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THESIS

A COMPARATIVE FINANCIAL ANALYSIS OF THE U.S. DEFENSE INDUSTRY DURING THE POST COLD WAR DEFENSE DRAWDOWN

by

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December 1995

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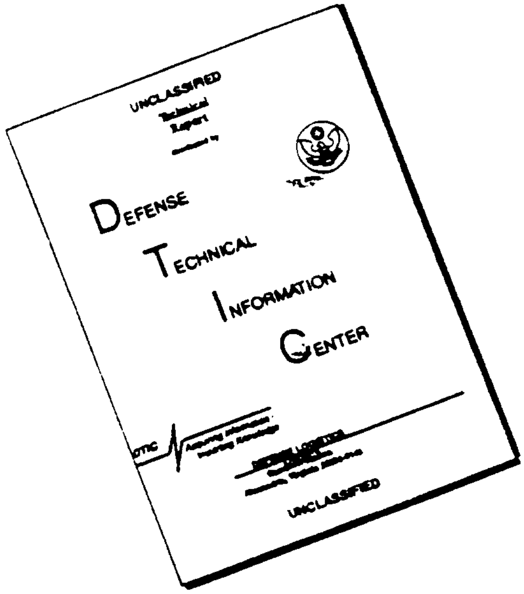

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ABSTRACT

The on-going defense drawdown has left leaders in both Government and industry concerned over the survival of the U.S. defense industrial base. The purpose of this thesis is to explore whether or not such concern is warranted, given the various strategic efforts undertaken by the management of U.S. defense firms to ensure that their companies remain competitive, profitable, and financially viable despite shrinking defense budgets. Using eight different financial ratios as performance measures of solvency, efficiency, and profitability, this thesis examines the financial viability of 28 defense contractors from 1986 through 1994. Graphical and statistical analytical techniques are used to: identify ratio trends; measure defense industry performance compared to U.S. manufacturing industry averages; and identify the relationship between defense firms' strategic commitment to/dependence on defense business and their financial viability over the period of the defense drawdown. The thesis concludes that the solvency ratio trends show steady to improving conditions, while the trends for efficiency and profitability ratios are somewhat mixed. Analysis also shows that, compared to the U.S. manufacturing industry at large, the defense industry was less solvent, less efficient, and more profitable over the period of the drawdown. However, the more defense-dependent firms were generally more solvent, more efficient, and less profitable than defense firms whose strategies indicated less dependence on defense business.

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I. INTRODUCTION

A. BACKGROUND

1. Overview

With the end of the Cold War, the United States Department of Defense (DoD) is faced with the task of downsizing the very same Armed Forces which contributed to the Cold War victory. However, caution must be taken to ensure that we maintain a strong and viable military which is both well-trained and well-equipped. Military commanders are responsible for the training and readiness of the forces, but they must rely on the *defense industrial base* to continue to provide them with state-of-the-art equipment. As clearly demonstrated during the Gulf War, the U.S. military is both technically and tactically superior to any military in the world. The world watched as we showed off the sophisticated weaponry which had been developed through lengthy and expensive research and development (R&D) efforts conceived to counter the threat from our Cold War adversary. But gone are the days of military expansion and technological advancement brought on by enormous defense budgets.

Without an identifiably strong threat, the DoD is faced with the difficult tasks of "right sizing" the military force structure, and reducing spending for the research and development (R&D) and procurement of expensive new weapon systems to replace those which have already proven to be the best in the world. By 1997, the DoD expects the defense budget to have declined by 41% from its peak in the mid 1980's. Furthermore, by fiscal year '98, the defense budget is expected to have fallen to about 3% of the Gross National Product (GNP), compared to over 6% in the mid-'80s. [Ref. 63: p.1] Many of these reductions will be achieved through cancellation or scaling back of weapons procurement and R&D programs. But what effect will taking this *peace dividend* from defense contractors have on the viability of the defense industry? Perhaps William Anders, Chairman and Chief Executive Officer of General Dynamics (GD), one of this country's

premier defense prime contractors, best expresses the concerns of many defense firms in his March, 1991 letter to GD's shareholders,

> The easing of Cold War tensions, welcomed from a humanitarian point of view, is removing the major market stimulus for U.S. defense spending which was already under stress due to the increasing Federal deficits. In addition, ill-conceived alterations of Department of Defense contract terms and conditions, along with contractor overcapacity, have adversely affected profit margins and cash flows throughout the defense industry over the past several years. [Ref. 11: '91, p. 5]

There is much debate among politicians, the DoD, defense industry executives, and lobbyists on how best to convert defense savings to cure the social and economic ills of a country which, despite its stature as the world's only superpower, is rapidly becoming a second-rate economic power. The Defense Conversion Commission (DCC), a DoD organization formed in 1992 to assess the consequences of the defense drawdown, and to make recommendations constructively addressing them, spoke of the peace dividend as not just the amount of money saved on defense spending, but rather,

> ... the opportunity to reallocate to other productive activities the resources and talent made available as defense spending declines.... The national challenge of conversion is to seize this opportunity and accomplish the reallocation in the most timely and efficient way possible while still preserving the appropriate defense industrial base. [Ref. 61: p. 5]

Indeed, the defense industrial base provides different opportunities to many stakeholders. To Congress collectively, it is an easy (since defense spending is discretionary) way to reduce the Federal deficit, but to individual lawmakers it provides high-tech, high-paying jobs to voters. According to the Congress' Office of Technology Assessment (OTA) [Ref. 54], in 1991, nearly one-half of all defense-related jobs (both Government and private sector) and spending occur collectively in the following states: California, Texas, Virginia, New York, Florida, Massachusetts, Ohio and Pennsylvania. Obviously, elected officials in these states might have less of a nationalistic view of the defense drawdown. This "not in my back yard" paradox exemplifies the complexity of drawing down the defense industry. Defense firms rely on defense contracts to achieve

profits and returns to shareholders, and to provide jobs and therefore larger tax bases to local communities. To the soldiers, sailors, airmen, and marines who must rely on sophisticated modern weaponry produced by it, the defense industrial base provides the capability of fighting and winning our Nation's military conflicts with minimal casualties. To the men and women in uniform, superior weaponry is more vital to national security in today's environment, where the threat is largely undefined, than it was during the Cold War, when we knew both our enemy and the area of operations. To small and minority-owned businesses, the defense industry offers the opportunity to compete via various socio-economic programs mandated by law and DoD regulation. However, the recent "anti-Affirmative Action" sentiments among many conservatives may threaten these businesses which were previously guaranteed receipt of Government contracts which were statutorily set aside for such businesses.

Without knowing the true effect of the drawdown, both Government and industry proponents of these defense programs argue that "the defense industry's sky is falling", and favor continued "Government support" (synonymous with budget appropriations) for efforts to preserve a strong and capable defense industrial base. Equally unaware of the true impact of the drawdown on industrial base viability, opponents of these programs argue to let competition and the free enterprise system drive the financial viability of the defense industry.

2. The Defense Industrial Base

The U.S. defense industrial base is made up a multitude of private and public companies, most of which also produce goods and services in the commercial marketplace. These companies range from huge, high-tech, Fortune 500 companies with globally diversified business interests, to small, low-tech, "Mom and Pop" operations which manufacture selected piece parts used in other components, systems and sub-systems. Defense industry companies operate in many tiers ranging from: prime and sub-contractors of systems and sub-assemblies, to vendors and suppliers of component

parts and raw materials. The Services and installations within the DoD rely on the defense industrial base for a broad array of products and services from development and production of complex major weapons systems such as aircraft, ships and tanks, to base support such as phone service, and consumables such as fuels and subsistence items.

The industrial base also consists of a number of Government laboratories and maintenance depots. Many of the labs are operated by major universities and conduct much of the Nation's basic and applied research. Many of the Government maintenance and ammunition depots are operated by defense contractors under Government-owned contractor-operated (GOCO) arrangements. However, these Government laboratories and depots not only complement the efforts of defense contractors, but, to the dismay of defense firms, often compete with them. The active pursuit of new business by Government entities within the defense industrial base has been brought on by ongoing efforts to down size the defense infrastructure through the Base Realignment and Closure (BRAC) process. Indeed, this is a case of competition fostered by the survival instinct.

The largest amount of defense spending, in terms of contract dollar value, goes to a shrinking number of large defense prime contractors. The degree of reliance on defense sales for these companies varies widely. One group, exemplified by firms like General Dynamics, Grumman, and McDonnell Douglas, rely on the DoD for over one-half of their total sales. Another group, such as Martin Marietta, Lockheed, and Raytheon, are not only defense-dependent, but they are also largely dependent on business from other Government agencies, such as the National Aeronautical and Space Administration (NASA) and the Federal Aviation Administration (FAA). A third group consists of firms which are commercially diversified, and rely on the DoD for less than one-third of their business. Examples of such firms are United Technologies, Boeing, and Rockwell International. Still a final group consists of firms which are fundamentally commercial, but maintain defense divisions or subsidiaries. Example firms are Westinghouse, General Motors, IBM, ITT, and GTE. [Ref. 54: p. 29]

Defense industry firms have developed a variety of strategies for addressing the defense drawdown. The first, and most fundamental, strategic decision to be addressed by these firms is whether to stay concentrated on defense business or broaden their business bases to include more commercial enterprises. The OTA discusses the following eight strategic options to cope with defense downsizing: shrinking in size; exporting arms and military technologies; shifting to similar commercial products; sales to civilian (non-defense) Government agencies; spin-off companies; corporate diversification; and defense conversion. In an attempt to cut overhead and reduce idle capacity, many firms have chosen to shrink by closing plants and laying off workers in order to concentrate on core defense businesses. A popular strategy for keeping production lines warm is to expand production to include sales to foreign customers. This option, which includes the Foreign Military Sales (FMS) program and the exporting of technology to enable co-production within friendly nations, also helps reduce the unit costs to the U.S. defense customers. However, in an uncertain world, this option is risky, as today's ally could potentially become tomorrow's enemy during some regional conflict. The option of shifting defense business assets to commercial businesses is directly related to the degree of similarity between the firm's defense and commercial products. For instance, this option is especially attractive to manufacturers of products such as: transport aircraft, aircraft engines, and communications and electronics. On the other hand, such a strategy is infeasible for makers of tanks, fighter aircraft and battleships for which, fortunately, there are no commercial customers. As a "first line of retreat" strategy, some firms have increasingly sought after and received business from other Government agencies such as: NASA, the FAA, the National Weather Service, the Department of Energy (DoE), and the Department of Transportation (DoT). This option is attractive to defense firms which develop and produce space systems, satellites, and electronic sensors and control systems. Some defense firms have formed separate companies to exploit military technologies for commercial use. The value of this spin-off strategy is in transfer of military technology into commercial products and services. The strategy among defense firms of diversifying

into commercial markets through the purchase of going concerns which are already somewhat successful in their respective lines of commercial business. By operating these commercial business units as subsidiaries, the parent company hopes to reap profits with little managerial or marketing involvement in unfamiliar markets. This strategy was popular in the '60s and '70s as U.S. firms (not just defense firms) acquired diverse strings of business as a method of hedging against declining corporate profits. However, historically many of these diversification efforts failed as corporate management became too heavily involved in businesses they knew nothing about, thereby resulting in huge corporate losses as subsidiary profits often fell below the expectations of the parent. The last strategy available to defense contractors is that of *defense conversion*. This option, whereby defense firms develop, produce and bring to market commercial products using assets (i.e., capital, plant, property and equipment, and intellectual property/engineering know-how) previously devoted to defense products, is the least attractive strategy among the major defense contractors, and warrants further discussion. [Ref. 54]

Although the definition of defense conversion will change with the party providing the definition, it is generally defined as the process of/for demilitarization of the contractors making up the defense industrial base [Ref. 25: Sec. 2, p. 6]. Note this definition avoids the political pitfalls of a more specific (and politically correct) definition provided by the General Accounting Office (GAO): "Defense conversion refers to a number of Federal programs intended to help individuals and communities cope with cutbacks in military spending and to support the defense technology and industrial base." [Ref. 70: p. 1] A concept which is directly related to defense conversion is *dual-use technology*. Dual-use refers to the components, processes, and systems which have both military and commercial uses [Ref. 3: p. 1]. Dual-use is not a "cure-all", but a key piece in the defense conversion puzzle which is controlled by a multitude of disjointed policies and organizations.

The DoD Advanced Research Projects Agency (ARPA , formerly known as DARPA) defines the term *dual-use* "with respect to products, services, standards,

processes, or acquisition practices, respectively, that are capable of meeting requirements for military and non-military application." [Ref. 58: p. 6] Note, technology can flow in either direction after originating in either defense or commercial markets. This flow ties dual-use to technology transfer and defense conversion. "Dual-use is the end result of a successful technology transfer program, but it is also the end result of a successful defense conversion process." [Ref. 25: Sec. 1, p. 7] ARPA has established a unique niche as DoD's agency for fostering and managing dual-use efforts. ARPA is a lean organization of only 160 employees, but wields a great deal of respect, and controls an ever-increasing budget [Ref. 31: p. 124]. Five of ARPA's offices control direct research toward core technologies in electronics, microelectronics, computing, software, and materials, and control over 80% of its $2.25 billion budget. In a move intended to formalize ARPA's previously *de facto* role as the dual-use technology agency, in February 1993, President Clinton ordered them to drop the "Defense" from their name [Ref. 55: p. 29].

Although large defense firms remain somewhat cautious and reluctant to pursue dual-use product development, the Electronics Industries Association (EIA) reports that firms within the defense electronics industry are embracing the concept as a cause for optimism in the face of declining defense budgets [Ref. 7]. A number of factors support the EIA position. First of all, DoD no longer leads, but follows the commercial sector in key technology fields such as electronics and information processing. Since commercial customers are driving product demand and development, leading edge technologies are frequently being developed first for the commercial users. DoD is finding its needs are being given lower priority, and must therefore hope to "spin on" promising new commercial advancements into military applications [Ref. 61: p. 23]. Any defense market losses are expected to be made up for in commercial markets. Secondly, as funding for major weapon systems is reduced, some new start programs will be canceled in favor of upgrading/enhancing current systems. By extending weapon system life cycles through the addition of more capable electronics, this strategy supports goals of cost reduction and industrial base sustainment. Lastly, most analysts feel that electronics, in general, are the

easiest types of technology to transfer from military to commercial applications. The Global Positioning System (GPS) and heads-up display technologies are good examples of new-found, easily transferred dual-use technologies [Ref. 44: p. 4-4]. While corporate managers within the defense electronics industry understand the necessity to embrace the dual-use concept, there is a cultural hurdle to cross in order to move into commercial markets. Business practices have changed from the "good old days" of boundless R&D, funded by DoD under cost-plus-fee contracts. Customers in the commercial electronics sector demand quality, value, and service. They seldom pay for R&D, and almost never buy from suppliers under cost-reimbursable types of contracts [Ref. 66: p. G-2]. Because of this, the dual-use concept has become an extremely attractive method for getting the Government to share the risks and costs of R&D which the commercial customer is unwilling to support.

Although some defense firms consider their strategies toward their future business activity their business alone, a key defense industrial base issue is that of the Government's role (if any) in the transition of defense firms into more commercial activities. Indeed, some have argued that the best U.S. defense industrial base policy is none at all. Concerning the need for and content of a national industrial/technology base policy, there are as many opinions as there are bureaucrats in Washington. While conservative politicians generally favor letting global markets decide technological and economical winners and losers, their liberal counterparts tend to support a more active Government role in this area. President Clinton believes that an industrial policy will soon become a major part of efforts to rebuild U.S. global competitiveness, but supports a less Government and more private sector solution. His views were expressed in a written statement, in September 1992, as a candidate for President:

> America cannot continue to rely on a trickle down technology from the military to the competitiveness of its high tech and manufacturing industries. Civilian industry, not the military, is the drawing force behind advanced technology today.... Although the Government has a role to play in restoring America's competitiveness, most responsibilities must be with the private sector. [Ref. 5]

The major defense contractors recognize that industry firms themselves can and will make the majority of the changes needed to rationalize the defense industrial base, but caution that the Government's industrial base role should be to provide policies which help rather than hinder the process. A particular example of such a hindering Government policy is that which dictates second-sourcing acquisition strategies in defense procurement. The criticism of dual-sourcing was expressed by the CEO of GD in the company's 1991 Annual Report as follows:

> This practice redirects production volumes and transfers critical data and innovative designs to program losers, thereby keeping winners from achieving efficiency and reducing their incentives to invest in new technology for the future. [Ref. 11: '91, pp. 6-7]

Although criticized by the General Accounting Office (GAO) as, "... not a realistic strategy for ensuring that government decisions and industry adjustments will result in the industrial and technological capabilities needed to meet future national security requirements", the DoD has taken the position that free market forces will generally guide the restructuring of the defense industrial base. The GAO cites as a key reason for this criticism that defense firm managers are concerned with maximizing returns for investors, and are therefore neither concerned with nor accountable for how the long-term changes within the defense industry affect national security. Espousing a somewhat "isolationist" point of view, the GAO also criticizes the DoD industrial base strategy for not playing a proactive role in assessing the U.S. reliance on foreign sources and foreign investment within the defense industry. However, the DoD industrial base strategy does call for its active role in monitoring and assessing the defense industry to ensure the preservation of products, processes, and industrial capabilities which are critical to national security. [Ref. 71]

In July 1995, the Office of the Assistant Secretary of Defense for Economic Security, ASD(EA), published a draft DoD Directive entitled *Assessing Defense Industrial Capabilities* which provides defense and service acquisition officials with policy

and guidance concerning assessment of critical defense capabilities. The following statements summarize the directive:

> The DoD shall not take an action or make an investment to preserve an industrial capability unless the action is the only cost and time effective alternative to meeting national security requirements.... Any proposed action or investment to preserve a capability with an anticipated cost of $10 million or more annually requires the approval of the [Under Secretary of Defense for Acquisition and Technology] USD(A&T). [Ref. 59]

The ASD(EA) also published a companion DoD handbook with the same name. The handbook provides various analytical techniques for assessing which industrial capabilities are critical to national defense, truly unique, and endangered by the defense drawdown. It provides the structure and techniques for acquisition officials to conduct in-depth analysis of the following questions [Ref. 66]:

- Is there a valid national security requirement for the product or service of concern to meet current or future military missions, readiness, or sustainment?
- What industrial capabilities are essential to making the product or service?
- Is any capability truly unique? Is any capability truly endangered?
- Have the cost, risk, and benefit of all feasible alternatives been evaluated?
- Is the recommended action the only avenue to ensure the DoD can meet its mission? Is it the most cost and mission effective solution?

The handbook also identifies the following courses of action and the decision criteria used to evaluate them: (1) take no action; (2) rely on a foreign source of supply; (3) use existing substitute products or capabilities; (4) make a buy-out to meet all future DoD needs; (5) apply a new solution involving new technology; (6) invest in a "smart shutdown"; (7) invest in an acquisition action to preserve the capability; and (8) rely on DoD procurement relief or restriction, export assistance, or policy relief. The handbook also details procedures for conducting cost-benefit, break-even, and financial analyses. Finally, the document mentions two strategies the DoD will undertake to ensure the U.S.

maintains a superior technology and industrial capabilities at an affordable price. The first strategy is to rely on an industrial base that is sustained by commercial demand, but capable of meeting defense needs. By using commercial products and services, the DoD benefits from cost efficiencies and technological innovations which are available from a much larger commercial market. The second strategy is to take advantage of cost and technological benefits afforded the DoD by access to the best global suppliers. In support of this strategy, the DoD is pursuing cooperative international development programs because they provide sharing of development costs, access to new technologies, and access to an international industrial base. [Ref. 66]

3. The Defense Budget

Revenues received from the DoD by firms which provide defense-related products and services are derived from annual Defense Appropriations Bills passed by Congress and signed into law by the President. More commonly referred to as the annual defense budget, the defense appropriation provides the services and defense agencies the *budget authority* which allows various procurement activities to enter into contracts which *obligate* these monies. When the defense contractor fulfills the terms and conditions of the contract, the previously obligated monies are paid to the contractor in the form of *outlays* from the U.S. Treasury. The defense budget is categorized by type (also known as "color") of funding as follows: Operations and Maintenance (O&M); Military Personnel (MILPERS); Military Construction (MILCON); Research, Development, Test and Evaluation (RDT&E); and Procurement. These funding categories not only relate to the different purposes of their expenditures, but also have different durations during which the appropriated funds must be obligated. For instance, O&M and MILPERS funds expire annually; and RDT&E, Procurement, and MILCON funds expire in two, three, and five years respectively. The procurement and R&D funding categories still represent the largest portion of the defense budget, and provide funding for development and procurement of defense systems.

During the Cold War, the defense budget consumed a substantial amount of the country's resources. As a percentage of the Gross Domestic Product (GDP), defense spending ranged from 4.8% in 1978 to 14.5% in 1953. Its most recent peak was at 6.5% of GDP in 1986 during the height of the "Reagan build-up". A 1993 report by the DoD's Advanced Research Projects Agency (ARPA) estimated that, "Because of major changes in the geopolitical environment and pressing social and economic needs... By 1997, the DoD budget is expected to fall to 3.6% of GDP, the lowest... since the end of World War II". [Ref. 58: p. iii]

Defense budget outlays are planned to decline from $380 billion in 1987 to $237 billion in 1997 (a 30% reduction). The largest outlay reductions (46%) over this period will come from military procurement accounts. At the same time, DoD R&D outlays are expected to shrink by nearly 24%. However, these reduction plans are less severe than those following World War II, the Korean War, and Vietnam. Not only is the current drawdown expected to be a smaller reduction in terms of percentage of GDP, it will occur at a slower rate than its three predecessors. [Ref. 61: pp. 9-10]

In support of over 700 Federal laboratories, the Government pays for 43% of the Nation's R&D. Most (69% in the mid '80s) of this R&D was spent on defense. In 1992, the Federal Government spent $68.2 billion overall on R&D out of a national total of $157.4 billion; $41.5 billion of this was defense-related. [Ref. 38]

Figures 1-1 through 1-4 reflect the changing nature of the most recent defense budget authority and outlays, in actual (then year) dollars and constant (1987) dollars respectively, for calendar years '86-'94 (equivalent to fiscal years (FY) '87-'95).

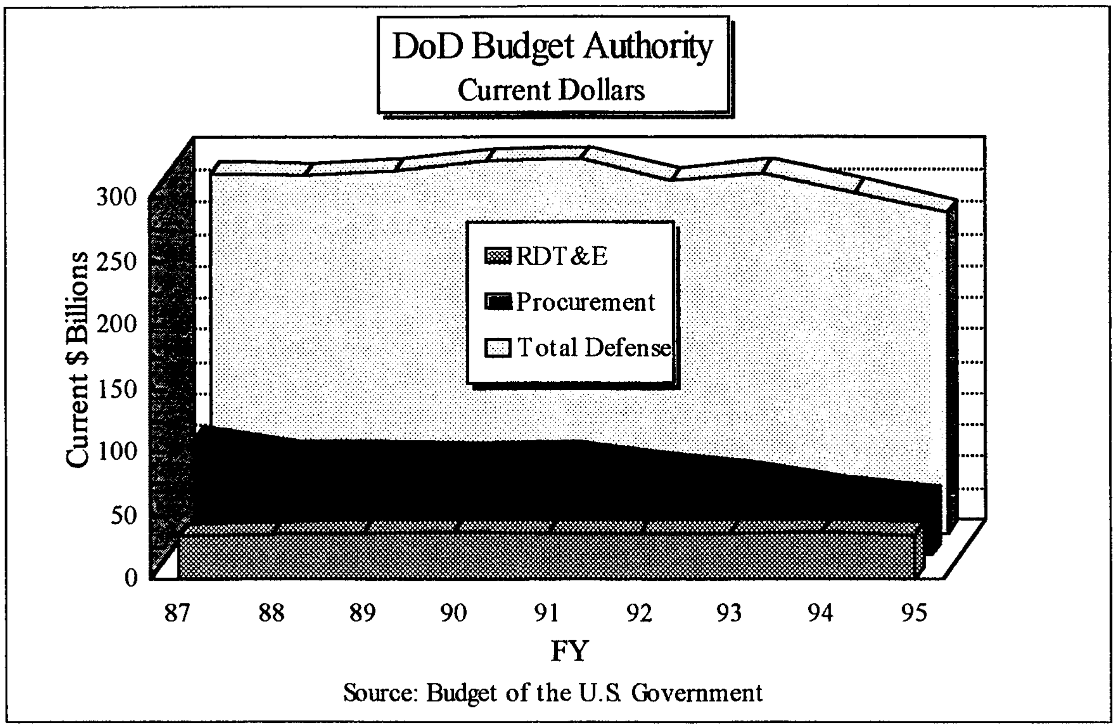

Figure 1-1. DoD Budget Authority, Current Dollars, FY '87-'95.

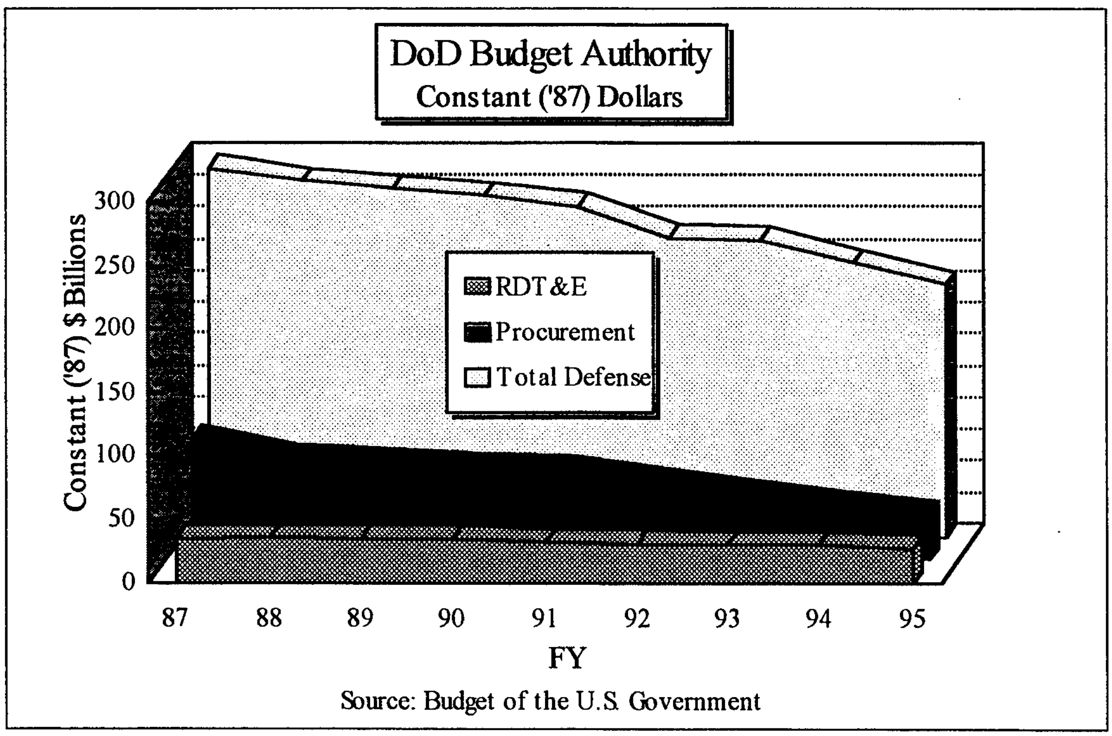

Figure 1-2. DoD Budget Authority, Constant ('87) Dollars, FY '87-'95.

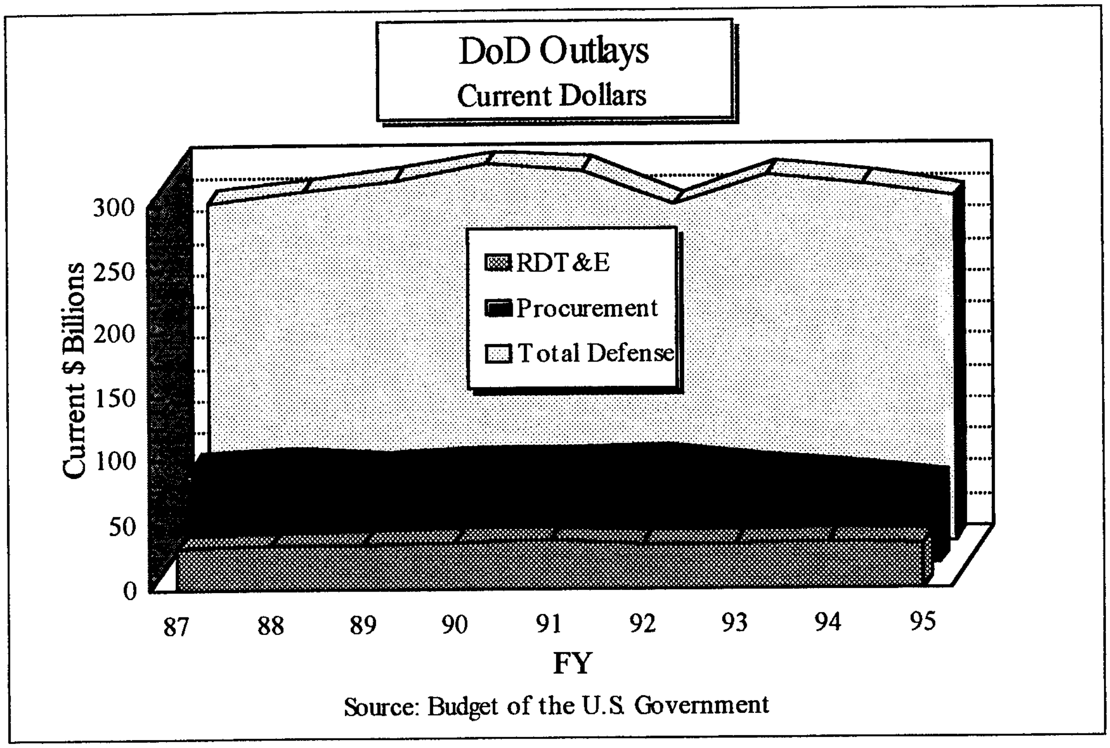

Figure 1-3. DoD Outlays, Current Dollars, FY '87-'95.

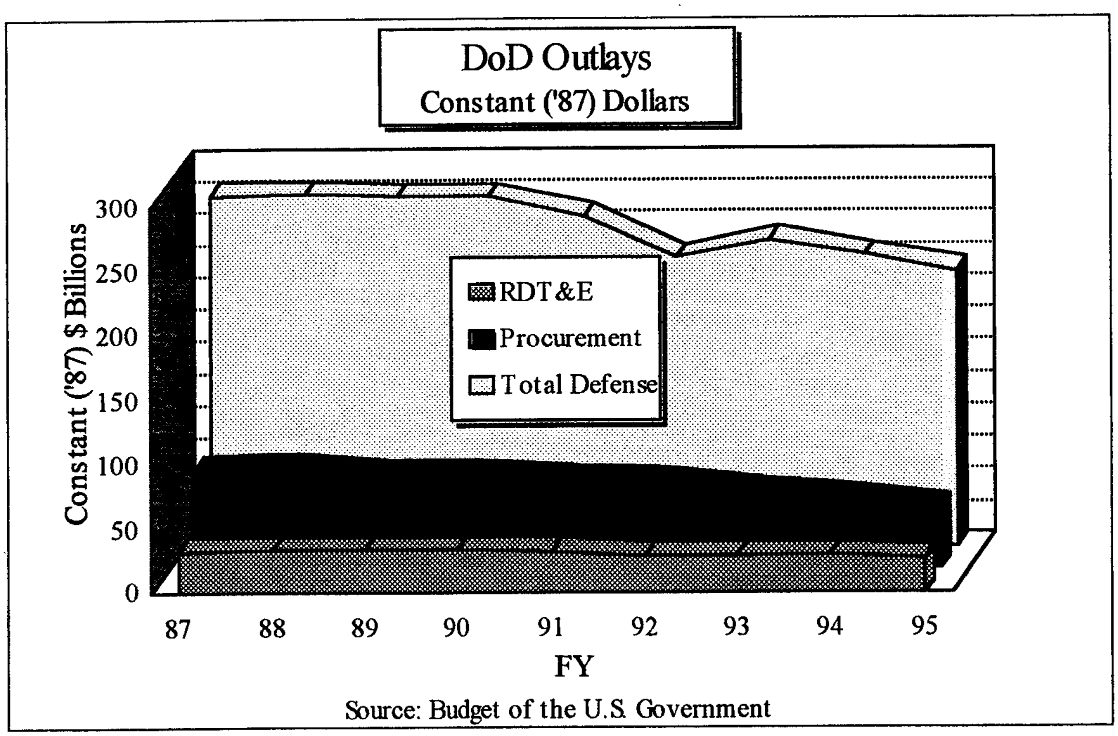

Figure 1-4. DoD Outlays, Constant ('87) Dollars, FY '87-'95.

4. The Defense Acquisition System

The DoD procures products and services through the defense acquisition system. This system consists of a myriad of laws, regulations and management practices which were adopted for laudable purposes such as: to protect the Government's interests; to prevent fraud, waste, and abuse of tax dollars; to ensure the Government acquisition process is fair; and to further social and economic objectives. The August 1993 *Defense Performance Review/Strategic Plan for Acquisition Reform* cited the following examples as policies, regulations, or practices which may have outlived their utility in the post-Cold War era [Ref. 63: p.4]:

- Military specifications were adopted to ensure we got a quality product that would meet the user's needs while using a procurement process that would allow us to buy from the lowest bidder;

- Cost Accounting Standards and the requirement to provide cost and pricing data were adopted to ensure the government could make an "apples-to-apples" comparison of the bids of various contractors and as a mechanism to ensure the government paid a fair and reasonable price for what it was purchasing;

- Checks on the government's authority were established to in essence "protect the people," in this case suppliers, from certain government demands;

- Technical data has been requested to ensure the government can operate, repair and maintain its equipment without fear of being held hostage to a sole-source supplier for spare parts and to obtain reasonable spare parts prices through competition;

- Other provisions of law, such as the Davis-Bacon Act, requirements to use small businesses, and buy only American-made products were adopted to further a particular interest; and finally,

- Oversight within DoD and oversight of its contractors has burgeoned and the process increasingly criminalized to ensure there is no fraud, waste, or abuse of the system.

The report considers these and other such rules and regulations to be "barriers to the use of commercial practices, the purchase of commercial products, and the integration of the

defense and commercial industrial bases." [Ref. 63: p. 5] The report also criticizes the current defense acquisition system as follows,

> The combined net effect of these laws, regulations and practices is a system which: adds unnecessary costs to the products of defense contractors, making it harder for them to be competitive in the commercial marketplace, prevents the government from acquiring products from commercial contractors unwilling to change their practices to accommodate rules unique to government contractors, and adds to DoD's cost of doing business -- its "management and control" costs. [Ref. 63: p. 5]

In order to successfully implement industrial base policy, DoD and other Government agencies must eliminate various regulatory barriers to defense conversion and commercial diversification efforts. Two specific barriers have been targeted for change under the umbrella of acquisition reform: overuse of military specifications and standards; and Government business practices, audit, and oversight requirements. These and other sweeping acquisition reforms are addressed in the Federal Acquisition Streamlining Act of 1994 (FASA), for which Government agencies are currently drafting implementing regulations and guidance.

For years all companies manufacturing goods for the Government have complained of our reliance on cumbersome, outdated, unnecessary, and costly military specs. For years these complaints have fallen on the deaf ears of Government procurement officials accustomed to using detailed design specs to tell defense contractors precisely "how" to manufacture items. Finally, Defense Secretary Perry has directed DoD, "to use performance and commercial specifications and standards in lieu of military specifications and standards, unless no practical alternative exists to meet the user's needs." [Ref. 67]

Additional regulatory barriers to companies in the defense industry are the Government-unique oversight, accounting, and management practices imposed upon Government contractors. As stated previously, excessive Government oversight drives up the prices the DoD pays for defense systems. The requirement for contractors to submit cost or pricing data is valid in some instances to ensure that both the Government and the

contractor are negotiating on a level playing field. The requirement for contractors to use Cost Accounting Standards (CAS) can also help the Government achieve cost oversight and reduce fraud, but the additional costs caused by these and other oversight requirements are significant, as indicated by the studies of RAND and others,

> ... the existing regulatory regime imposes additional costs of between 10 and 50 percent on the cost of doing business with the DoD. How much fraud the regulations deter is impossible to estimate, but it must certainly be less than the $15 to $75 billion represented by 10 to 50 percent of the acquisition budget. [Ref. 56: p. 71]

In fact, these additional costs are so high that any losses incurred by eliminating such stringent and costly oversight requirements would certainly be acceptable by commercial standards [Ref. 3: p. 19]. These requirements discourage defense contractors from consolidating their commercial and Government business within the same plants. Unless they segregate their facilities, labor, and material, companies will be forced to charge higher overhead rates to both their Government and commercial customers. Any effort to force higher overhead onto commercial products will stifle efforts such as defense conversion, dual-use, and consolidation of the defense and commercial industrial bases.

In 1993, in support of efforts to identify barriers and facilitate defense-commercial transition, the EIA conducted a survey of 33 companies which collectively received a third of the defense budget [Ref. 7]. The survey revealed that DoD firms perceived significant changes in Government laws and regulations were required if they were to be competitive in commercial markets. Specifically, industry sources identified: excess Government paperwork requirements, concerns over safeguarding of proprietary information, Government audit/accounting procedures which force separate Government and commercial sides to business units. [Ref. 25: Sec. 2, p. 14]

Just as the defense industrial base has a number of different stakeholders with differing agendas, so too has the defense acquisition system. Among these interested parties are: Congressional representatives; defense and service acquisition executives; defense contractors; lobbying groups from industry groups and those representing social

causes; defense and Service program managers (PMs) and procuring contracting officers (PCOs); Government audit and oversight groups such as the GAO, the DoD Inspector General (DoDIG), and the Defense Contract Audit Agency (DCAA); and the operational military forces (i.e., the "user"). Each of these participants have strong incentives for supporting or opposing defense acquisition programs.

To a defense contractor, such programs represent new business opportunities and profits to shareholders. However, defense contracts do not guarantee profits, as can be illustrated by the Navy's terminated A-12 program. In 1988, the contractor team of McDonnell Douglas and General Dynamics signed a fixed-price-incentive contract to develop the high-tech, radar-evading, stealthy attack aircraft. In 1991, the program was terminated for default after the contractor team experienced schedule delays and costs which exceeded the value of the contract by $2.7 billion. Although a prudent business person might question the selection of a fixed-price contract type for such a technically complex program, these contracts offer the potential of higher profits for contractors with superior technology, who understand the risks and costs associated with the program. Cost-type contracts, on the other hand, place most of the cost and technical risks on the Government, as contractors are guaranteed reimbursement for all of their reasonable, allowable, and allocable costs, in addition to a specified range of profit, for merely their best developmental efforts. Generally, fixed-price contracts are used for production, and cost-reimbursable contracts are used during system development. However, historically this has not always been the case. After World War II, during the 1950s, cost-reimbursable defense contracts were the norm. However, in the 1960s Secretary of Defense (SECDEF) McNamara restricted the use of such contracts in favor of fixed-price contracts. This preference was overturned in 1970, as Deputy SECDEF David Packard influenced a policy whereby the contract type was to be tailored to the risks involved with a particular program. [Ref. 47: pp. 207-9]

Support or opposition of defense acquisition programs by members of Congress is often incentivized by constituency interests. As previously discussed, most members of

Congress outwardly favor cutting defense spending, but the individual members disagree as to which programs should be affected and how. The following excerpt from a GAO report illustrates the nature of Congressional involvement in defense acquisition,

> Even when DoD makes the difficult choice of canceling a program, the Congress, in some instances, continues to support it. Such was the case during the 1992 budget process, when DoD decided to discontinue the M-1 tank modernization, the V-22 Osprey aircraft, and SSN-21 Seawolf submarine programs. Each of these programs continued to receive support by key congressional committees, and DoD eventually withdrew its opposition. [Ref. 72: p. 39]

Clearly these decisions had more to do with jobs than with defense requirements. The DoD did not plan to discontinue these programs because they lacked military merit, but in an environment of lean defense budgets, tradeoffs must be made to bring defense needs in line with defense affordability. Such Congressional actions circumvent and upset the defense planning, programming, and budgeting system (PPBS). The 1993 *Report of the Defense Science Board Task Force on Defense Acquisition Reform* likewise criticized Congress for adding $8 billion in the FY '92 budget for weapons procurements which it explicitly stated was for maintaining the defense industrial base. Not only did some of these actions result in grossly inefficient program stretch-outs, but much of this funding was not even requested by DoD. [Ref. 64: p. C-10]

DoD and Service acquisition executives, and PMs are often incentivized to "oversell" their respective programs to other stakeholders in order to maintain reputations, careers, and shares of the defense budget for their programs. The present culture of defense PMs provides that their programs must meet the exit criteria for the next major milestone in order for them to succeed in their military or civil service careers. Since a PM's statutory period of service is only for four years or the next major milestone (which ever comes first), they often inherit troubled programs that are already behind schedule and over cost, have infeasible acquisition strategies, or no longer enjoy the support of the user (in terms of requirements) or Congress (in terms of steady funding). After speaking with and working with a number of military PMs from all three Services, it is clear to this

researcher that no PM was ever promoted for recommending that his program be canceled! To the nominated or appointed defense acquisition officials and Service executives, whose tenures are often relatively short, defense programs can be an effective way to leave a legacy by making short-term decisions with long-term consequences. The GAO elaborates that, with such motivation,

> ... programs -- like the B-1 -- that are eventually fielded despite performance, cost, and other significant problems are often considered more successful than programs -- like the Sergeant York -- that are canceled because serious flaws were discovered before fielding. When in conflict with responsible management, "successful" outcomes may carry more rewards. [Ref. 72: p. 38]

When the topic of Government audit, inspection and oversight is discussed, one cannot help but think of the "rice bowls" involved within the various agencies which conduct these functions. These enormous bureaucracies have traditionally served as the watch dogs for Congress and the DoD, but as the defense drawdown threatens to reduce the size of these organizations, many believe that their primary mission has become one of self-preservation. One point is clear, these participants in the defense acquisition process often receive much of the blame for the so called "adversarial relationship" between the DoD and defense contractors. These organizations have traditionally inspected defense acquisition programs for shortcomings as they were approaching major milestones. However, SECDEF Perry has recently embraced the common private sector concept of Integrated Process and Product Development (IPPD) for use by DoD to,

> ... make team decisions based on timely input from the entire team (e.g., program management, engineering, manufacturing, test, logistics, financial management, procurement, and contract administration) including customers and suppliers. [Ref. 68]

The concept calls for all acquisition functions, to include oversight, to employ a spirit of teamwork to "design in" success, not "inspect out" failure.

B. OBJECTIVE

The on-going drawdown in U.S. defense spending has left leaders in both Government and industry concerned over the survival of the U.S. defense industrial base. Although the industrial base debate has a number of aspects, the most important aspect of its long-term survival is the financial viability of the firms which conduct defense business. The primary purpose of this thesis is to explore whether or not such concern for the defense industry is warranted, given various strategic efforts undertaken by the corporate management of U.S. defense firms to ensure that their companies remain competitive, profitable, and viable as going concerns despite shrinking defense spending.

C. RESEARCH QUESTIONS

The primary question to be addressed is:

- *How has the post Cold War defense drawdown affected the financial viability of major U.S. defense prime contractors?*

The subsidiary questions to be addressed are:

- *What strategic measures have major defense prime contractors taken to enhance their corporate financial viability in the face of shrinking U.S. defense spending?*
- *How has the defense drawdown affected the solvency of U.S defense firms?*
- *How has the defense drawdown affected the efficiency of U.S defense firms?*
- *How has the defense drawdown affected the profitability of U.S defense firms?*

D. METHODOLOGY

While there are a variety of techniques used to conduct financial analysis, most include the use of various financial ratios as metrics for determining and conveying financial information. Such ratio analysis involves the collection of data elements from financial statements such as balance sheets and income statements, and combining these

data to form fractions. The mathematical relationships between numerator and denominator values serve as measures of financial effectiveness and performance. But a ratio value, whether represented as a whole number, percentage value, or number of days, is meaningless by itself. It is only when such ratios are compared with other ratio values that they can be used for analysis. "Ratios help analysts make meaningful comparisons of one firm with another by removing most of the effects of size differences." [Ref. 8: p. 690]

This study was conducted in five phases: (1) literature research; (2) financial ratio selection; (3) sample selection; (4) data collection and synthesis; and (5) data analysis. First, a thorough review of available literature was conducted via the libraries of the Naval Postgraduate School and the Monterey Institute for International Studies, the Defense Logistics Studies Information Exchange (DLSIE), and the Defense Technical Information Center (DTIC). The literature review focused on studies of the defense industry, in general, and financial ratio analyses, specifically.

The next phase involved the selection of the most appropriate financial ratios to use as measures of financial effectiveness/performance. Financial ratios are generally categorized by function, and are thus classified as: solvency, efficiency or profitability ratios. While there are other ratio classifications, these are the ones most commonly referred to in the accounting literature. The following ratios were chosen as being most indicative of: (1) solvency - debt to equity (DE), current ratio (CR), and collection period (CP); (2) efficiency - working capital to total assets (WCTA), inventory turnover (ITO), and collection period (CP); (3) profitability - return on assets (ROA), gross margin ratio (GMR), and return on investment (ROI).

The next phase required the selection of a sample of defense prime contractors which was both manageable within the constraints of this thesis, and representative of the defense industry at large. The following 28 companies were selected for evaluation and are listed by industry in Value Line's *Investment Survey* as follows: (1) aerospace/defense - Boeing, E-Systems, General Dynamics, General Motors, Litton Industries, Lockheed, Martin Marietta (note: Lockheed Martin formed in March 1995), Loral, McDonnell

Douglas, Northrop, Grumman (note: Northrop Grumman formed in April 1994), Raytheon, (note: Raytheon now owns E-Systems) and Rockwell International; (2) diversified - ITT, Textron, and United Technologies; (3) computers and peripherals - IBM and Unisys; (4) natural gas - Tenneco; (5) steel (integrated) - LTV; (6) telecom service - GTE; (7) machinery - FMC; (8) semiconductor - Motorola and Texas Instruments; (9) electronics - Harris; (10) electrical equipment - General Electric, Honeywell, and Westinghouse. These companies were chosen by the researcher because they consistently (over the period of study) represented the largest dollar values of defense contracts, manufacture a variety of both defense and commercial products, and have diverse corporate strategies towards their defense business in the post Cold War era.

Data collection consisted of obtaining the annual reports for corporate fiscal years (equivalent to calendar years for most firms) 1986 to 1994 from the sample companies. Additionally, during this phase, line of business information was gathered in order to fully understand corporate organizations and nature of business bases for the sample companies. Business line information was required to separate the sample companies into sub-groups based on factors such as: relative sizes (percentage) of defense and commercial business bases, industry labeling/categorizing, and strategic efforts such as acquisition or divestiture of defense business sectors. Financial ratio data and corporate strategies were gleaned from these reports. These data were supplemented by Value Line's *Investment Survey*, Standard & Poor's *Corporate Records,* and Dun & Bradstreet's *Industry Norms and Key Business Ratios*. These data were entered into a series of Lotus 1-2-3 spreadsheets for synthesis and computations of financial ratios for individual firms and stratified groups, as well as various descriptive statistics used to conduct the graphical and statistical analysis during the analysis phase of the research.

During data collection and synthesis, the sample firms were not only segregated by lines of business, they were also separated according to their level of participation in the defense industry. The criteria used to group sample firms were: the Value Line *Investment Survey* industry classification of each firm; the amount of defense/Government business

relative to commercial business; and strategy toward their existing and future participation in the defense industry. For instance, firms which are classified by Value Line as aerospace/defense firms, and/or receive a large portion of their sales revenue from DoD, and/or have adopted strategies which indicate a desire to remain competitive in the defense industry are classified as "defense-dependent" firms. On the other hand, those firms whose Value Line classification, defense sales volume, and corporate strategies so indicate are classified as "defense-indifferent" firms. These groupings facilitated statistical analysis of the data.

The research concluded with a comparative analysis of the financial data. This analysis utilized two analytical techniques: graphical/visual analysis and statistical tests of hypotheses. In order to evaluate the solvency, efficiency, and profitability of each individual sample firm, the ratio data were used to create a series of line charts displaying the value of all eight ratios for each firm over the entire period of study. These charts were used to graphically display and evaluate trends and anomalies over the nine year period '86-'94. The charts and a brief evaluation of the financial ratios of each of the sample firms are presented in Chapter III of this thesis -- **DATA PRESENTATION**. Similarly, line charts were used to visually display and evaluate sample defense contractor ratio values compared to industry averages or *norms* for these same ratios. In order to create these charts, an analysis was conducted to determine the Standard Industrial Classification (SIC) codes in which sample defense contractors most often operated. The norms for the various manufacturing industry SICs were obtained from Dun & Bradstreet's *Industry Norms & Key Business Ratios*, and included the median, upper quartile, and lower quartile data. These charts are presented in Chapter IV of the thesis -- **COMPARATIVE ANALYSIS**.

The statistical analysis of this thesis consisted of tests of a variety of hypotheses about the average (or mean) values of various ratios of the sample firms as compared to each other and to industry averages. The statistical concept of hypothesis testing allows researchers to assess the validity of some conjecture about an unknown population

parameter based on data from a representative sample of the population. A series of one-sample, one-sided t-tests of hypotheses were conducted to determine whether or not, with regard to selected financial ratios, the defense industry (as represented by the sample firms) was either better off, the same as, or worse off than all manufacturing firms in selected manufacturing industry groups. The financial ratios used for these tests were: the current ratio (CR), collection period (CP), and return on assets (ROA).

Similarly, a series of two-sample, one-sided t-tests of hypotheses were conducted to determine whether or not, with regard to selected financial ratios, the defense-dependent firms within the sample were either better off, the same as, or worse off than the defense-indifferent firms within the sample. The financial ratios used for these tests were: the current ratio (CR); inventory turn over (ITO); and the gross margin ratio (GMR). The results of the hypothesis testing are presented in Chapter IV -- **COMPARATIVE ANALYSIS**-- of the thesis:

E. SCOPE, ASSUMPTIONS, AND LIMITATIONS

As previously mentioned, there are a number of issues surrounding defense industrial base viability in an era of defense downsizing. These aspects include, but are not limited to: U.S. technology and industrial base policy; surge capability and capacity (i.e., industrial mobilization); foreign penetration into U.S. defense markets; raw materials supply (excesses and shortages) and foreign dependency; the impacts on American jobs and communities; and the financial viability of U.S. defense firms. However, this thesis attempts only to analyze the latter aspect. While these and other industrial base concerns are interrelated, the author believes financial viability to be the most important aspect of defense industry health and survival. Although this thesis mentions some of these other industrial base issues, their in-depth analysis is beyond the scope of this thesis. Furthermore, the previously mentioned background information on the defense industrial base, the defense budget, and the defense acquisition system is intended to give the reader some insight into the environment in which defense firms operate. Although policy makers should benefit from the findings, conclusions and recommendations of this

research, detailed analysis of U.S. policies and procedures concerning the aforementioned topics is also beyond the scope of this thesis. Also, in defining the scope of this thesis, the time span chosen to represent the current defense drawdown was from 1986 (the height of the Reagan build-up) to 1994 (the last year complete annual corporate financial data were available).

It is assumed that the financial viability of the defense industrial base depends strongly on the financial positions of the major defense prime contractors. This assumption is supported by the fact that these companies have been under contract for the majority of total defense spending (approximately 50%) over the period of study. Although some of the classical statistical techniques used during this research require random sampling techniques, this requirement was not met, as random sampling is required only to ensure that the sample is representative of the population being studied. Since these sample firms contract for nearly half of all defense spending, and they collectively develop and produce every type of system, product, and service the DoD buys, randomness is unimportant. Gathering data from a random sample of defense contractors would also have proven prohibitive, given the time constraints of the study, and ultimately would not have increased the accuracy of statistical tests. Another major assumption is that the financial ratio data for U.S. defense contractors are *normally* distributed, since the formulae used during the statistical analysis require them to be. Although it is practically impossible (short of computing the ratio values of every U.S. corporation) to determine that the population distribution is precisely normal, such an assumption can be inferred for the data used in this thesis. First of all, the literature review revealed several similar, previously published financial analyses which also assumed normality of such data. Secondly, the Central Limit Theorem holds that the assumption of normality is relaxed in cases with a relatively large sample size. In fact, this theorem allows us to conclude that for large samples, the sampling distribution of the sample mean will be approximately normal, even when the population distribution is not normal. [Ref. 39: pp. 329-337]

Finally, there were a number of limitations encountered during the research. First of all, the reader must understand the problems associated with conducting financial analysis of companies by using data from consolidated financial statements, problems especially challenging when researching defense firms. These problems were summarized by a fellow NPS student as follows, and are just as appropriate for this thesis,

> The study of financial condition of companies over time is inherently difficult because of accounting changes over time, management and technology changes over time, diversification of companies into various industry segments, ... variations in data reported by financial information (statements), and tax policy changes. The financial condition of DoD contractors is further complicated by timing differences of reports, Government procurement policy changes.... [Ref. 77: p. 65]

Another limitation was the use of several financial ratios which may hold negative values when computed. Although such conditions (caused by either negative working capital, net income, or equity) still allow the researcher to make judgments about a firm's financial condition, the magnitudes of such negative ratios are meaningless, and would skew statistical computations. Chapter II -- **METHODOLOGY** -- provides a more detailed discussion of these conditions and the measures taken to mitigate their effects.

II. METHODOLOGY

A. LITERATURE REVIEW

Literature was obtained from the following sources: the libraries of the Naval Postgraduate School and the Monterey Institute for International Studies, the Defense Logistics Studies Information Exchange, and the Defense Technical Information Center. The literature review focused on two areas: previous studies on the defense industry, and previous financial ratio analyses. The economic impact of the defense drawdown on the defense industrial base in general, and selected industry sectors (i.e., aerospace, electronics, etc.) in particular, is somewhat uncertain since the market appraisals depend on the prognosticator/analyst. In order to show the different perspectives on the conditions (financial and otherwise) experienced by defense industry firms, it was important to seek literature published by a variety of sources from both industry and Government. Although some might consider reports from industry groups such as the Aerospace Industries Association (AIA) and the Electronic Industries Association (EIA) biased, they are good sources for identifying the hopes and fears of firms doing business with the Government in general and specifically the DoD. Reports published by Government sources such as the Office of Technology Assessment (OTA), the General Accounting Office (GAO), the Defense Conversion Commission (DCC), and the DoD's Advanced Research Projects Agency (ARPA) might also reflect the biases of the executive and legislative branch leaders they serve, but are no less useful in showing the Government perspective on defense industrial base concerns. Finally, there are a number of studies which attempted to be unbiased, some of which were conducted by fellow NPS students.

1. Defense Industry Studies

In 1983, the DoD chartered the Defense Financial and Investment Review (DFAIR), an organization with the objective of studying and making recommendations concerning defense contract pricing, financing, and profit policies to determine if public

funds were being spent efficiently. Covering the period of 1975 to 1983, the DFAIR was also to determine the status of the defense industrial base. The DFAIR concluded that the interests of the taxpayer were being protected, and companies in the defense industry were achieving equitable returns on their defense business. [Ref. 62]

In a separately published Appendix 3 entitled *Financial Community Perceptions of the Defense Industry*, the DFAIR examined the perceptions and concerns of leaders in the nation's financial community concerning defense contractors. Financial institutions contacted for the study included: commercial banks, life insurance companies, accounting firms, investment rating agencies, investment banking firms, and venture capital firms. Perhaps the perceptions of investment bankers best summarizes the rosy financial picture of a defense industry which was building up prior to 1985,

> ...investment bankers consider defense contractors to be in excellent financial condition at the present time, especially the top dozen or so firms in the industry. They have sufficient cash and are using it for debt reduction, acquisitions of other companies, adding to plant and equipment, increasing dividends, repurchasing stock, and reducing their liabilities for deferred taxes.... (defense) contractors are considered profitable, managements are well regarded, and... the outlook for these major firms is bright,... and they can get all of the money that they want. [Ref. 62: p. 39]

The study also concluded that defense contractors: possessed ample liquidity; had little need for bank financing; had little demand for long-term funds; and were not highly leveraged. [Ref. 62]

A 1986 GAO report on the DFAIR study questioned the methodology used in the review, and concluded that defense contractor profits were actually greater than those in the commercial sector [Ref. 69]. A 1985 NPS thesis entitled *DoD Contractor Profitability 1980-1984* similarly concluded that, during this period, defense contractors were more profitable and exposed to less risk than like-sized commercial businesses [Ref. 34].

The Defense Conversion Commission, a DoD organization formed in April 1992 to assess the consequences of the defense drawdown, published a December 1992 report

entitled *Adjusting to the Drawdown.* The report concluded that, "the financial viability of the 25 largest DoD prime contractors is not at risk and that they will probably manage the drawdown successfully." The DCC report also addressed the trend of acquisitions and mergers within the defense industry as an effective means of adjusting to reduced defense spending and excess capacity problems. Lastly, the report identified three basic strategies adopted by defense firms to cope with the drawdown: rationalizing (i.e., concentrating on their core defense capabilities through acquisitions and mergers while shedding unprofitable defense business segments), increasing exports, and diversifying into new markets (particularly commercial markets). [Ref. 61]

The outlook within the communications-electronics segment of the defense market is somewhat mixed. In a 1993 analysis of the industrial base, the U.S. Army Industrial Engineering Activity predicts, "Of all the U.S. industries which have an involvement in production of defense-related products, the electronics industry will be the least affected by major defense budget reductions now being implemented." [Ref. 44: p. 4-3] However, a study conducted by the Industrial College of the Armed Forces cautions that, since DoD procures its communications-electronics equipment from a small number of large defense contractors, market conditions within this sector are dependent on the future strength of the major defense companies [Ref. 20: p. 6]. According to the Logistics Management Institute's (LMI) Defense Economic Impact Modeling System (DEIMS), DoD purchases 50% of the nation's communications and search and navigation equipment from an industry grouping projected to suffer a 21% reduction in its business base between 1991 and 1997 [Ref. 80: p. iv]. However, the Electronics Industry Association (EIA) projects that, while overall defense spending will decrease during the next 10 years, defense spending on electronics hardware is expected to remain relatively unchanged over the same period [Ref. 44: p. 4-3].

The outlook for the aerospace segment of the defense industrial base is also somewhat mixed, as reflected in the Aerospace Industries Association's (AIA) *1992 Year-end Review and Forecast.* According to the AIA review, segment sales fell 4%

during 1992 from a record high of $139 billion the previous year. A 7% ($4 billion) reduction in DoD purchases of aerospace products and services caused much of this decline in sales. Sales of military aircraft and parts were down 9% ($3.6 billion). The review also showed a slight increases in the sales of civil aircraft and space-related products and services. However, sales within these sectors actually fell in terms of constant dollars. This year marked a change in these two sectors of the aerospace industry as both had experienced strong growth over the previous decade. Although aerospace industry net profits rose marginally in 1992, profits for the years 1991 and 1992 were lower than at any time since 1982. The AIA stated that these lower profits were caused by extraordinarily large non-operating expenses brought on by restructuring charges related to defense downsizing, and implementation of Financial Accounting Standard (FAS) 106, which required firms to account for costs of employee post-retirement benefits other than pensions. FAS 106 affected all U.S. companies, and manifested itself as a balance sheet adjustment by increasing liabilities and reducing equity. FAS 106 additionally affected income statements by lowering net profits. The '92 AIA review additionally found that profits as a percent of sales, assets, and equity improved for the aerospace industry (as they did for all of manufacturing), but industry profitability, as measured by these ratios, still underperformed the averages for all manufacturers. [Ref. 1]

The mere title of a 1988 study prepared by the Air Force Association (AFA) is indicative of the "Chicken Little" fears among certain Government and industry officials concerning survival of a strong defense industrial base. Despite its biases, this document, entitled *Lifeline in Danger; An Assessment of the Defense Industrial Base*, provides a thorough evaluation of the defense industry, and what Government efforts have been or should be adopted to rectify problems. The study primarily focuses on problems associated with mobilization of the defense industry to meet surge production in the event of a major conflict. According to this study, a key contributor to mobilization problems is the increasing U.S. reliance on foreign sources of supply for both raw materials and high-tech military components (e.g., semiconductors). While this problem and its root

cause are beyond the scope of this thesis, it shows the "isolationist" attitude among U.S. defense industry interests who want to sell their wares abroad, but vehemently oppose defense imports and foreign penetration into U.S. markets. The report also provides helpful perspective on problems associated with defense research and development (R&D). Despite total Government outlays for R&D rising by 40% over the period 1983 to 1988, the defense share of these expenditures has slowly been decreasing since 1965. The report claims the R&D deficit is exacerbated by Government policies which expressly disallow reimbursement of defense contractor Independent Research and Development (IR&D) costs. Not only has the DoD underfunded R&D, but during the 1980s, in an attempt to encourage private industry to take on more of the financial and development risks associated with defense R&D programs, fixed-price contracts became the norm within DoD. These fixed-price R&D contracts caused huge losses for many defense contractors. The study also reported the results of a survey of the AFA's Industrial Associates. Regarding profitability, 98% of respondents reported profitability had been affected by changes in tax laws and procurement regulations and such changes were unfair to defense contractors. The survey also indicated that two-thirds of the respondents felt that these changes had a negative impact on their decisions to bid on some Government contracts. Also, 95% of survey respondents reported stretchouts of defense programs, which had a negative impact on their financial situation and that of their subcontractors. [Ref. 2]

The Air Force funded a 1994 RAND study entitled *Financial Condition of U.S. Military Aircraft Prime Contractors*. The study examined the effects of declining defense spending on the financial conditions of the seven military aircraft prime contractors active during the 1980s: Boeing, General Dynamics, Grumman, Lockheed, McDonnell Douglas, Northrop, and Rockwell. The RAND study summarizes its findings as follows:

> Overall, a correlation is apparent between size, profitability, level of debt, R&D spending, and the degree of dependence on U.S. Government sales. The less defense-dependent firms generally are larger in terms of sales and more profitable, and have lower debt/capital ratios and higher R&D/sales ratios, but this pattern has a few exceptions. [Ref. 42: p. 94]

The study also found that, with the possible exception of McDonnell Douglas (MDC), none of the sample contractors currently appeared to be in danger of going bankrupt. To support its position regarding MDC, the report cited the firm's recent liquidity crisis, and impending liabilities on several contracts which are not being acknowledged on the company's balance sheet. The report also cautions that the apparently healthy financial conditions within the defense aircraft market do not fully reflect the effects of declining defense budgets because of lags in defense spending. RAND also echoed the negative financial effects of the preferred use of fixed-price R&D contracts by the Government during the '80s. These contracts resulted in reducing profits and increasing debt for all seven military aircraft prime contractors. Finally, the report reiterated the effect of FAS 106, as previously addressed by the AIA study. [Ref. 42]

The Office of Technology Assessment (OTA), a congressional support organization, published a report entitled *After the Cold War; Living with Lower Defense Spending.* This report discusses several aspects of the defense drawdown as they affect: policy issues and options, displaced defense workers, displaced military, states and communities, and defense companies. Only the first and last aspects of the report are applicable to this thesis. The report offers opinions and recommendations on various programs to assist the transition of defense technologies and production capabilities to more commercial use. It also discusses efforts such as: tax incentives for defense conversion, intellectual property rights, and contractor IR&D cost recoupment. The OTA report addresses the strategies undertaken by the major defense prime contractors to cope with the defense drawdown. It also groups the major contractors according to business base characteristics such as industry segment and percent of DoD sales. [Ref. 54] In an ironic twist of fate, the office which produced this report has recently been closed by the Congress -- an apparent victim of the very defense drawdown it reported on.

2. Financial Ratio Analyses

Although its methodologies were not applied to this thesis, a book entitled *A Cross-Industry Analysis of Financial Ratios*, provided some useful insight into the

financial conditions within the defense industry over the period of its study, 1978-1987. The following quote summarizes the authors' conclusions regarding the defense industry:

> In general, we find that short-term effects are much more volatile in this industry whereas most of the long-term ratios are stable, and higher levels of fluctuation are observed in working capital from other than operations and in current debt numbers. These represent the significant lead times needed to adapt to economic changes, a direct result of the highly specialized and capital-intensive production technologies involved. [Ref. 24, p. 200]

In a 1991 study conducted for the Center for Naval Analysis entitled *Financial Analysis of the Major Defense Contractors*, Michael Treglia analyzed the financial performance (using nine financial ratios) of twelve major DoD prime contractors from 1984 to 1989. Tregila's conclusions were: (1) the major DoD prime contractors had trouble adjusting to the decline in DoD spending in the second half of the '80s; (2) low returns by these firms made their ability to attract equity financing more difficult; (3) increased debt by these firms raised the cost of financing for these firms; (4) with decreased DoD procurement, the trend will lead to fewer resources and fewer firms in the defense industry. [Ref. 53]

A graduate thesis by NPS student Michael Vormbroke entitled *An Analysis of the Relationship Between the Financial Condition of Major Defense Contractors and DoD Spending* examined the relationship between defense contractor financial condition and defense spending from 1975 to 1990. The thesis examined this relationship at two levels: the defense industry in the aggregate, and the individual contractor level. The methodology included the use of two financial distress/bankruptcy models to examine financial variables of 18 defense prime contractors. The major findings of this thesis were: (1) the defense industry in the aggregate has experienced a declining financial condition over the period studied; (2) a positive relationship seems to exist between the financial condition of the defense industry and the amount of defense spending (i.e., as the amount of DoD contract awards decreases, the financial condition of the defense industry as a whole will probably continue to decline); (3) no consistent relationship between the

financial condition of the 18 different individual defense contractors and the amount of defense spending is apparent. [Ref. 77]

In his thesis entitled *The primary Dimensions of Financial Condition for Firms Within the Defense Industry*, NPS student Robert White examined the primary dimensions of financial condition for firms within the defense industry. White conducted a factor analysis of 32 financial ratios for 50 defense firms over the period 1983 to 1992. He further examined whether such dimensions were represented by a specific subset of financial ratios and whether these dimensions and ratios are stable across time. The thesis concludes that the following nine factors indicate the primary dimensions of financial condition in the defense industry: profit, working capital, cash position, cash flow, inventory, debt, liquidity, sales, and receivables. He also found that the following ratios most effectively captures the full range of these financial dimensions: Total Income (plus depreciation) to Total Assets, Working Capital to Total Assets, Cash Flow to Total Assets, and Current Assets to Sales. Finally, White concluded that these dimensions and ratios are stable across time. [Ref. 79]

Another NPS thesis, *Financial Ratio Patterns in the U.S. Defense Industry*, by Guner Gursoy, researched the effect of the dramatic political and economic changes (during the period 1983 to 1992) on financial ratio pattern of defense industry firms. He compiled 15 financial ratios for a sample of 38 defense contractors over the ten year period of study. The author's methodology included the use of statistical techniques such as t-tests and analysis of variance (ANOVA). The thesis concluded: (1) profitability declined and risk increased in the defense industry; (2) recent years had shown increasing dispersion (less uniformity) in financial condition across defense industry firms; (3) there was some indication that ratios in the most recent years of the study had become more stable, suggesting that the period of greatest turmoil for the defense industry may have passed. [Ref. 18]

The aforementioned RAND study also provided financial analysis using ratios. The study states that declining shareholder equity, debt to sales ratios over 20%, and debt

to capital ratios over 50% are all indicative of financial weakness. In order to get a rough estimate of potential future financial problems, the debt to sales ratios were projected for all seven defense aircraft manufacturers. This was done by holding their debt levels constant while reducing their military sales (a portion of the denominator) by incremented percentages. [Ref 42] The study found that,

> Although several firms appeared to have potential problems on the basis of 1990 and 1991 debt levels, most of them have reduced debt dramatically over the past few years. Only Lockheed and McDonnell Douglas have debt/sales ratios that could exceed 20 percent if their U.S. defense sales fell by 25 percent. The remaining firms do not appear to be in danger unless their U.S. Government sales fall by 75 percent or more, and Boeing and Rockwell's debt/sales ratios would be below 20 percent even if their U.S. Government sales fell to zero. [Ref. 42: p. xvii]

A graduate thesis by Georgia Tech student Romeleo Punsalan, entitled *Bankruptcy Prediction in the Construction Industry: Financial Ratio Analysis*, studied the application of two manufacturing industry financial distress/bankruptcy models (those used in the Vormbroke thesis) in the construction industry [Ref. 43]. While the findings and conclusions of this thesis are irrelevant, its analytical techniques (i.e., t-tests and hypothesis testing) help to validate statistical assumptions made during the conduct of this thesis. These assumptions, principally that financial ratio variables are normally distributed, are also supported by the text *Analysis of Financial Statements: Financial Accounting and the Capital Market* [Ref. 15] and the Gursoy thesis mentioned previously [Ref. 18].

B. FINANCIAL RATIOS

While there are a variety of techniques used to conduct financial analysis, most include the use of various financial ratios as metrics for determining and conveying financial information. Such ratio analysis involves the collection of data elements from financial statements such as balance sheets and income statements, and combining these data to form fractions. The mathematical relationships between numerator and denominator values serve as measures of financial effectiveness and performance. But a

ratio value, whether represented as a whole number, percentage value, or number of days, is meaningless by itself. It is only when such ratios are compared with other ratio values that they can be used for analysis. "Ratios help analysts make meaningful comparisons of one firm with another by removing most of the effects of size differences." [Ref. 8: p. 690]

Because financial ratios are so widely used in both Government and industry for a variety of purposes, there are a large number of them (well over 100, depending on the source). Financial ratios are generally categorized by function, and are thus classified as: solvency, efficiency or profitability ratios. While there are other ratio classifications, these are the ones most commonly referred to in accounting literature.

1. Solvency Ratios

Solvency ratios, also known as liquidity ratios, measure the ability of a firm to meet both its short and long-term debt paying obligations. These ratios are very important to credit managers and lending institutions. If a firm is to remain solvent as a going concern, it must obviously pay its creditors and stockholders. The term liquidity refers primarily to short-term assets. Liquid assets (such as accounts receivable or marketable securities) are cash and those assets that can be easily converted to cash in order to meet financial obligations. The solvency ratios selected for this thesis were: debt to equity ratio, current ratio, and collection period. They are defined as follows:

- Debt to Equity = Total Liabilities ÷ Total Equity.
- Current Ratio = Current Assets ÷ Current Liabilities.
- Collection Period = 365 × Average Accounts Receivable ÷ Net Sales.

The debt to equity ratio measures the proportion of a firm's total liabilities (or debt) provided by creditors relative to that provided by stockholders. It is measured either as an absolute numeric value or as a percentage. [Ref. 8: p.693] In general, total liabilities should not exceed total equity (i.e., a ratio of 1.0 or 100%) since, in such cases, creditors have more at stake than owners. For this ratio, lower data values are considered better when compared to debt to equity values of other firms. This ratio is termed total liabilities

to net worth in Dun & Bradstreet's *Industry Norms & Key Business Ratios*. Since this reference represents this ratio value as a percentage, so too does this thesis.

An assessment of a firm's short-term liquidity, the current ratio measures the degree to which a firm's current assets will cover its current liabilities. The ratio is presented as a numeric number representing the number of times current assets are to current liabilities (i.e., a value of 3.0 indicates that current assets are three times the amount of current liabilities). While no ratios have absolute desirable values, a current ratio value of 2.0 or higher is considered good. Creditors typically prefer a firm's current ratio be as large as possible, but since current assets earn very small returns relative to earnings from investments in long-lived assets, management must minimize the proportion of capital invested in current assets in order to maximize profits. [Ref. 8: p. 692] For this ratio, this thesis considers higher values to be better when compared to current ratio values of other firms.

A measure of both solvency and efficiency, a firm's collection period indicates the average number of days required to collect its receivables (i.e., how long to get paid). It also provides an indicator of the quality of a firm's receivables, and serves as a measure of the efficiency of a firm's credit policies. [Ref. 60: p. C-1] The lower a firm's collection period, the more solvent and efficient the firm is.

2. Efficiency Ratios

Efficiency is defined as the ratio of outputs to inputs. Efficiency ratios (also known as operating ratios) indicate how effectively a firm uses and controls its resources in order to generate sales revenues. These ratios are frequently presented in terms of the length of time required to consume or replace (i.e., turnover) selected assets. The shorter the asset turnover period, the more efficiently a firm is operating. [Ref. 14: p. 695] The efficiency ratios selected for this thesis are defined as follows:

- Working Capital to Total Assets = (Current Assets - Current Liabilities) ÷ Total Assets.

- Inventory Turnover = Cost of Goods Sold ÷ Average Inventory.

- Collection Period = (see solvency ratios above).

Working capital is defined as the difference between current assets and current liabilities. The working capital to total assets ratio measures the relative degree to which a firm is invested in short-term/quick assets and long-lived/fixed assets. When compared to the same ratio values of other firms or industry norms, higher values are better, and indicative of more efficiently operating firms. Firms with a negative value for this ratio (i.e., current assets less than current liabilities) also have current ratio values less than 1.0. Such firms are not only extremely inefficient, but are also relatively insolvent. The magnitudes of such negative ratio values are meaningless.

Inventory turnover refers to the length of time required to record a purchase and then sell the purchased goods to customers. The inventory turnover ratio measures the number of times a firm's inventory is turned over each year. More efficient firms turn their inventories over more frequently, and thus have higher ratio values. Because the value of inventories may fluctuate seasonally, the numerator measures a firm's average inventory throughout the year. Average inventory is computed by summing the inventory values at the beginning and ending of the year, and dividing by two. [Ref. 8: p. 696]

3. Profitability Ratios

Profitability refers to a firm's ability to generate earnings or "returns" for its owners. Profitability is a key parameter used by a firm's management when selecting candidate firms for merger or acquisition [Ref. 6]. Profits are also important to creditors as they provide a source for debt coverage. Profit ratios are generally measured relative to a number of bases such as assets, sales, or investment. When calculating these ratios, the effects of discontinued operations, extraordinary items, or accounting changes are excluded. [Ref. 14: p.325] Profitability will be indicated by the following ratios:

- Return on Assets = [Net Income + Interest (Net of Tax)] ÷ Average Total Assets.

- Return on Investment = [Net Income + Interest (Net of Tax)] ÷ Average Total Equity.

- Gross Margin Ratio = (Net Sales - Cost of Goods Sold) ÷ Net Sales.

Return on assets (ROA) measures the profits earned by a firm through the use of all of its capital (i.e., the total capital investment of both creditors and owners). These ratios are displayed as percentages. The key indicator of a firm's profitability, this ratio matches operating profits with the assets available to earn them. Profit, or return (the numerator) is computed by adding net income from operations (after taxes, and before extraordinary items and effects of accounting changes) to interest net of tax. Interest net of tax is computed by multiplying interest expenses by one minus the effective tax rate. The effective tax rate is computed by dividing income taxes by pre-tax income. Average total assets is computed by summing beginning and ending assets and dividing by two. [Ref. 8: p. 698] Firms which efficiently use their assets to turn higher profits will have higher ROA values while poorly run firms will be less profitable and will have lower ratio values. Firms which lose money in a given year (i.e., negative net income value on income statement), will have a negative ROA. Such a value is meaningless for comparison. While the negative value is indicative of poor profitability, the magnitude of the ROA is without meaning since a firm must achieve a positive value for net income in order to receive any return. During this analysis, negative ROA values were assigned values of zero. In order to prevent these data from skewing the results of graphical analysis, medians were determined (in lieu of means) where averages were called for. For statistical tests, these negative values were assigned a numerical value of zero to counter such an effect.

Return on investment (ROI) measures the profit earned by a firm through the use of capital (equity) supplied its owners. Also displayed as a percentage, this ratio is an effective measure of management's performance in maximizing returns for a firm's stockholders. [Ref. 8: p. 699] Generally, a value of at least 10% is regarded as a desirable

objective for providing funds for dividends as well as future growth. ROI is computed similarly to ROA with the exception of the denominator. Like ROA, ROI presents the same anomaly involving negative net income, and was treated similarly.

Gross margin is the difference between net sales revenues and the cost of goods sold. The gross margin ratio is a measure of the portion of each sales dollar that is gross margin (or gross profit). This ratio indicates the effectiveness of pricing, marketing, purchasing, and production decisions within a firm. Higher values are indicative of more profitable firms. Although one might expect this ratio value to increase by simply increasing selling prices of merchandise, such an action may actually lower a firm's gross margin ratio if sales volume were decreased by higher prices. [Ref. 8: p. 698]

C. THE SAMPLE

In selecting a sample of defense contractors, a representative and manageable number of companies was desired. Since samples from previous NPS theses researching the defense industry contained from 15 to 50 companies, this range was considered manageable. In order to select a representative sample, two selection criteria were used. First, the firms' DoD contract dollar amounts were considered. In order to ensure a representative sample, a target of 50% of all DoD contract dollars awarded in given years was established. Data on defense contractor rank and annual contract dollar amounts were collected from two periodicals: *Military Forum* [Ref. 37] and *Government Executive* [Ref. 36]. These data are presented in Table 2-1.

Company	'85 Rank	'88 Rank	'91 Rank	'94 Rank	'85 $Ms	'88 $Ms	'91 $Ms	'94 $Ms
Boeing	5	12	10	10	$5,462	$3,432	$2,424	$2,068
E-Systems	52	67	43	27	$370	$286	$434	$748
FMC	32	43	32	33	$834	$455	$650	$501
General Dynamics	2	3	2	9	$7,574	$6,043	$6,569	$2,817
General Electric	4	2	3	4	$5,880	$6,284	$5,823	$3,312
General Motors	19	11	4	3	$1,578	$3,609	$4,306	$4,368
Grumman	11	13	9	12	$2,736	$2,935	$2,725	$1,696
GTE	38	52	16	29	$603	$376	$1,305	$678
Harris	37	41	77	42	$693	$473	$184	$392
Honeywell	14	18	36	56	$1,905	$1,509	$546	$261
IBM	15	21	18	22	$1,785	$1,372	$1,235	$899
ITT	17	28	22	31	$1,603	$792	$947	$611
Litton Industries	20	14	14	14	$1,497	$2,477	$1,562	$1,563
Lockheed	6	7	7	2	$5,085	$4,354	$3,855	$5,739
Loral	66	55	35	11	$280	$355	$557	$1,746
LTV	18	25	21	41	$1,579	$998	$1,055	$403
Martin Marietta	10	4	5	7	$2,742	$5,092	$4,246	$3,188
McDonnell Douglas	1	1	1	1	$8,953	$8,264	$8,923	$7,218
Motorola	48	45	51	55	$461	$432	$358	$279
Northrop	25	33	29	8	$1,195	$613	$748	$2,963
Raytheon	9	8	6	5	$2,990	$4,124	$4,167	$3,290
Rockwell International	3	6	13	16	$6,260	$4,437	$2,230	$1,334
Tenneco	24	5	11	23	$1,250	$4,987	$2,371	$878
Texas Instruments	21	34	30	20	$1,425	$611	$746	$1,028
Textron	13	24	17	17	$1,951	$1,118	$1,246	$1,190
Unisys (Sperry)	16	17	15	28	$1,620	$1,554	$1,457	$707
United Technologies	7	9	8	6	$3,917	$3,754	$2,951	$3,236
Westinghouse	12	10	12	13	$1,953	$3,613	$2,274	$1,575
% of DoD Contract $s					49.3%	50.46%	49.11%	44.74%

Table 2-1. Contractor Rank & Contract Dollars.

Secondly, in order to ensure a representative sample, it was important to classify sample companies into various subindustries within the defense industry. As classified in the August '89 issue of *Military Forum*, the top defense firms are further segregated into the following product/service groups (among others): Ships; Vehicles (including both combat and non-combat); Aircraft (including both fixed and rotary wing, and engines); Missiles; Weapons; Computer Systems; Electronics and Communications; and Research and Development: [Ref. 37]

- Ships: Tenneco, Litton, General Dynamics, Westinghouse, GE, Unisys, Rockwell, GM, Textron, Raytheon.

- Vehicles: General Dynamics, FMC, Textron, GM, LTV, GE, Rockwell.

- Aircraft: McDonnell Douglas, United Tech., GE, General Dynamics, Grumman, Boeing, Lockheed, Rockwell, Textron, GM, Martin Marietta, LTV, Northrop, Raytheon, Westinghouse, Loral, E-Systems, IBM, Litton, Honeywell, Harris.

- Missiles: Raytheon, Lockheed, General Dynamics, GM, TI, McDonnell Douglas, Martin Marietta, Rockwell, LTV, Boeing, FMC, GE, Textron, Northrop, Westinghouse, Honeywell, Motorola, GTE, Loral.

- Weapons: General Dynamics, GM, GE, Boeing, FMC, McDonnell Douglas, Textron, Loral, Westinghouse, Honeywell, Lockheed, Unisys, TI.

- Computer Systems: Unisys, IBM, Honeywell, GM, Lockheed, Grumman, Boeing, Harris, Martin Marietta, McDonnell Douglas, GE.

- Electronics & Communications: Martin Marietta, Raytheon, Unisys, GE, ITT, Westinghouse, GM, IBM, Litton, TI, Grumman, Lockheed, Rockwell, Honeywell, GTE, Loral, Boeing, Harris, Northrop, Motorola, E-Systems, United Tech., General Dynamics, Textron.

- Research & Development: McDonnell Douglas, Martin Marietta, Boeing, GE, Raytheon, Grumman, Rockwell, Lockheed, GM, General Dynamics, United Tech., Textron, Westinghouse, Honeywell, Litton, Unisys, IBM, LTV, Northrop, ITT, TI, FMC, Motorola, Harris, GTE, Loral.

Since all of the proposed sample defense companies fall within one or more of the above product segments, the sample was considered representative of the defense industry as a whole.

1. The Boeing Company

Value Line classifies Boeing as a member of the aerospace/defense industry [Ref. 76: p. 554]. Prior to 1992, Boeing operated primarily in three industries: commercial transportation products and services; military transportation products and related systems; and missiles and space. The company now has consolidated and streamlined its operations into two business segments: commercial aircraft; and defense and space. The world's leading manufacturer of commercial jet aircraft, its product line includes the 737, 747, 757, 767, and 777. Boeing space systems efforts include(d) the Space Station Freedom

and the Inertial Upper Stage (IUS) booster rocket. Its defense programs include(d): the Avenger; Short Range Attack Missile; Peacekeeper Intercontinental Ballistic Missile (ICBM) Rail Garrison; the Sea Lance and Non-Line-of-Sight (NLOS) missiles; the B-2 Bomber (with Northrop); F-22 Advanced Tactical Fighter (ATF) (with Lockheed and General Dynamics); V-22 Osprey (with Textron); the 707 and 767 versions of the Airborne Warning and Control Systems (AWACS); CH-47D Chinook helicopter; RAH-66 Comanche helicopter (with Sikorsky); and E-6 submarine communications aircraft. Despite operating losses totaling $1.098 billion in its military segment for '88-'91, Boeing continues to be competitive and profitable in the defense market. Its strategy of involvement in broadly diversified defense and space business is seen by the CEO as a clear strength despite ongoing and inevitable cancellations and scale-backs in defense programs. Additionally, Boeing has downsized and reorganized its defense, space and missiles operations, by combining six divisions into a single profit and loss center -- The Defense & Space Group. By this consolidation, the company hopes to streamline operations to lower costs and improve productivity. [Ref. 4]

2. E-Systems Incorporated

Classified by Value Line in the aerospace/defense industry, the company develops, produces, operates, integrates, and supports high tech electronic systems for use in intelligence, reconnaissance, surveillance, navigation, and communications systems. E-Systems has five significant product segments: reconnaissance and surveillance (formerly electronic warfare); command, control and communications; navigation and controls; aircraft maintenance and modification; and other products and services. More than half of its business is classified by its primary customer -- the U.S. Government. Its '94 sales by customer were as follows: U.S. Government 89%, foreign Governments 9%, commercial 2%. The company is in a unique position relative to other defense contractors. It is not an aerospace company, although aircraft serve as platforms for many of its surveillance systems. Although not considered a "black box" company, it integrates such components into complex weapons and combat support systems. Key products and

services include(d): communications security devices; UHF shipboard communications systems; antennae systems for airborne NavStar Global Positioning System (GPS); ground and airborne reconnaissance platforms; and Government-Owned Contractor-Operated (GOCO) depot maintenance facility management. There are four basic elements of E-Systems' business strategy: renewed emphasis and commitment to its traditional business and customers; calculated expansion into non-traditional business; continuous performance improvements; and continued search for favorable acquisitions. Despite defense drawdowns, corporate management expects defense electronics budgets in general and the reconnaissance and surveillance segments in particular to continue along a level or increased path. As new-start programs become less affordable, more legacy systems will be enhanced via improved electronics. As the U.S. withdraws forces and weapon systems from various areas world-wide, greater emphasis is expected to be placed on intelligence collecting and processing, thereby enhancing the company's growth. Recently the company announced it is pending a purchase by Raytheon. [Ref. 9]

3. FMC Corporation

Classified by Value Line as a member of the machinery business sector, the company makes and sells a broad range of machinery and chemicals. Machinery is sold to industrial, agricultural, and defense customers. FMC is the world's leading producer of soda ash, and a major producer of phosphorus, hydrogen peroxide, agricultural chemicals, and lithium compounds. It operates 99 manufacturing facilities and mines in 21 countries. [Ref. 76: p. 1315] The company operates in five industry segments: performance chemicals; industrial chemicals; machinery and equipment; defense systems; and precious metals. FMC's key defense programs include(d): the M113 Armored Personnel Carrier; the M2 and M3 Bradley Fighting Vehicles; the chassis for the Multiple Launch Rocket System (MLRS); Trident missile tubes; various naval gun and launch systems (MK41 and 45); the Armored Gun System (AGS); and the Advanced Field Artillery System (AFAS). While the company is well entrenched as a sole or dual source supplier of armored ground vehicles, it has experienced declining returns on its defense business. In a strategic move

to further secure its strong position in this market, FMC combined its defense operations with complementary defense operations of Harsco Corporation's BMY Combat Systems Division to form United Defense Limited Partnership effective January, 1994. The company is jointly owned by FMC (60%) and Harsco (40%). The company is also expanding its defense business via international opportunities such as Foreign Military Sales (FMS) and joint ventures with customers such as Turkey, Saudi Arabia, Germany, Australia, Taiwan, Greece, Japan, and Pakistan. [Ref. 10]

4. General Electric Company

Classified as a member of the electrical equipment industry by Value Line, GE is one of the largest and most diversified industrial companies in the world. It operates in the following industry segments (percent of '94 sales shown): aircraft engines (14%); appliances (15%); broadcasting (8%); industrial products and systems (23%, includes lighting, locomotives, motors and industrial automation); materials (14%, primarily plastics); power generation (15%, turbine generators); and technical products and services (11%, medical systems and computer services). The company also owns GE Capital Services which provided the parent company with $2 billion in other earnings in '94. [Ref. 76: p. 1009] Major defense systems include(d): the F110 jet engine (for F-14 and F-16 aircraft); the F404 engine (for the Advanced Tactical Fighter and F/A-18); the F118 engine (for the B-2 bomber); the Aegis air fleet defense system; the Phalanx anti-missile defense system (second source); combat systems for the Seawolf submarine; systems engineering and integration for Strategic Defense Initiative (SDI) programs; antisubmarine warfare systems on surface ships; and the Army Tactical Command and Control System (ATCCS). However, except for military aircraft engines, the company exited the defense industry through its April, 1993 divestiture of its aerospace business segment. [Ref. 12]

5. General Dynamics Corporation

According to Value Line, the company operates in the aerospace/defense industry. Almost all of General Dynamics' revenues are derived from the U.S. Government. [Ref.

76: p. 560] During the period of this thesis, the company reorganized its business segments three times as follows: '86-'90 Government aerospace, submarines, land systems, and general aviation; '91 military aircraft, submarines, missile systems, land systems, and space systems; and '92-'94 nuclear submarines, and armored vehicles. U.S. Government sales (as a percent of total sales) over the period were as follows: '86-'91 84%-87%; and '92-'94 94%. Major defense systems include(d): the F-16 Falcon, the F-22 ATF (teamed with Lockheed and Boeing), and the A-12 (now canceled) aircraft (teamed with McDonnell Douglas); the Trident, the SSN-688 Los Angeles class, and the SSN-21 Seawolf nuclear attack submarines; the M1, M1A1, and M1A2 Abrams main battle tank; the Standard, Phalanx, Sparrow, Stinger and Tomahawk cruise missiles; the Inter-vehicular Information System (IVIS); and the Single Channel Ground and Airborne Radio System (SINCGARS). Since 1990, GD's strategy toward declining defense budgets has been to shrink itself. The principal focus of management has been to increase shareholder value which in '90 had declined by 71% from its '86 high. The main tenet of this strategy has been to sell off all business segments except those in which the company is either the top or second place producer. The outcome of this strategy has been the selling of its Missile Division ('91), Tactical Aircraft Division ('93), and its Space Launch Systems ('94) business units. The company is now a lean one which is the top producer of two products: submarines and armored vehicles. [Ref. 11] The A-12 debacle, whereby the Government terminated the contract for default in '91 due to excessive costs and schedule delays, caused GD's exit from the military aircraft market. However, the company hopes to gain a settlement likely ranging in the hundreds of millions, as the Federal Claims Court has ruled the Navy at fault for program termination [Ref. 76: p. 560].

6. General Motors Corporation

GM is the world's largest auto manufacturer. Automotive products accounted for over 81% of '94 sales. [Ref. 76: p. 105] Currently, the company has broken down its operations into five business sectors: North American Automotive Operations; International Operations; General Motors Acceptance Company (GMAC, principally an

auto financing/credit subsidiary); Electronic Data Systems (EDS, purchased in '84); GM Hughes Electronics (GMHE, purchased in '86 as Hughes Aircraft). All of the company's defense business is conducted via GMHE, a wholly-owned subsidiary, which operates three business segments: automotive electronics; telecommunications and space; and defense electronics. Although the company does not break out its defense business, GMHE accounted for 21.4% of GM's consolidated '94 earnings. In fact, GM boasts of GMHE's record earnings and revenues, as they have steadily increased since '92. GMHE's two business segmentd doing defense work, telecommunications & space and defense electronics, contributed 17.9% and 39.6% respectively to GMHE's '94 revenues. Key defense systems include(d): laser rangefinders and thermal imaging systems for the M1 tank; guidance electronics and sensors for Trident missiles; other missile programs including the Advanced Medium-Range Air-to-Air Missile (AMRAAM), Phoenix, Sparrow, Stinger, Maverick, Tomahawk cruise, and Tube-launched Optically-tracked Wire-guided (TOW); airborne radar systems for the F-14, F-15, F/A-18, AV-8B, U-2R, B-2, and AC-130 aircraft; the Army's Enhanced Position Location Reporting Systems (EPLRS); and the MK-48 Advanced Capability (ADCAP) torpedo. Recognizing the opportunities of the defense drawdown, GMHC's strategy to: (1) use acquisition (purchased GD's missile business in '92) and strategic alliances to increase market penetration; (2) leverage technology base into businesses that are extensions of core competencies with sustainable competitive advantages; and (3) consolidate defense business is rationalized in its '92 annual report [Ref. 13: p.20],

> With the reduction of new defense program starts for aircraft, ships, tanks, and communications systems, the trend toward upgrading existing platforms and systems should accelerate. Such modernization will require the type of advanced electronics systems that are GMHE's strengths.

7. Grumman Corporation

Grumman operates in the aerospace/defense industry. Prior to its '94 merger with Northrop, the company operated four business segments: aerospace; electronic systems;

information and other services; and special purpose vehicles. Grumman's key defense systems include(d): the F-14 Tomcat, A-6 Intruder, E-2C Hawkeye, EA-6 Prowler, EF-111 Raven, OV-1 Mohawk aircraft programs; the E-8 Joint Surveillance Target Attack Radar System (JSTARS); and the Integrated Family of Test Equipment (IFTE). Its strategy in the face of falling defense budgets has been to consolidate and restructure its military aircraft manufacturing operations. In '93 the results of these efforts were expected to be: a one-third reduction of its 15 million square feet of manufacturing, office, and warehouse space; and a 46% reduction in its number of employees since '87. [Ref. 16] The following quote from Grumman's last annual report ('93), serves as a precursor of its '94 merger (although Northrop actually purchased Grumman) with Northrop:

> Forty years ago, there were about 18 manufacturers of tactical aircraft. Today there are about five -- and the Department of Defense has said that within 10 years there will be only two. We cannot -- will not -- gamble Grumman's future on the dim chance that we will be one of them. [Ref. 16: '93, p. 3]

8. GTE Corporation

Value Line reports GTE as a member of the telecommunications service industry. The company owns the largest non-Bell telecommunications system, and serves 22.8 million access lines in 29 states, the Dominican Republic, Canada, and Venezuela. It is the second largest provider of cellular service, with a controlling interest in 77 metropolitan and 42 rural service areas. [Ref. 76: p. 757] GTE's operations are broken down into two segments: telephone operations (80% of revenues); and telecommunications products and services (20% of revenues). All of the company's defense business is conducted by its Government Systems Division, one of six business units within the telecommunications products and services segment. GTE Government Systems' products and services include: command, control, communication and intelligence systems; electronic defense systems; systems integration; tactical and strategic communication systems; communication switching and information systems. GTE's key defense systems include(d): the Army's Mobile Subscriber Equipment (MSE) tactical communications system; data processing for

the Air Force's Joint Space Command Intelligence Center; the Magic Mast antenna mast supporting the Patriot missile system; telephone switching systems providing secure communications for DoD at military command centers worldwide; and radio receivers as part of the Navy's Extreme Low Frequency (ELF) submarine communications system. Despite the defense drawdown, GTE's Government Systems business unit has continued to increase its customer base, receiving orders valued at $1.2 billion in '94. As a strategic protective measure, GTE is effectively obtaining customers from other Government agencies such as: the Departments of Agriculture and Transportation; the National Aeronautics and Space Administration (NASA); and the National Weather Service. Additionally, as defense sales have declined, GTE Government Systems has maintained its profitability by reducing costs more than enough to offset revenue declines. [Ref. 17]

9. Harris Corporation

A member of the electronics industry, Harris develops, designs, manufactures, markets, and services high-tech electronics systems (34% of '94 sales), semiconductor devices (19% of '94 sales), communications systems (19% of '94 sales), and office equipment and business communication products (Lanier Worldwide, 28% of '94 sales). [Ref. 76: p. 1037] These four product lines equate to the company's business segments. U.S. Government sales by all segments (although primarily from electronics systems) have been around 35% of total sales for the past three years. Since '90, the company has maintained 23-26% of its business base from the DoD. Key defense systems include(d): advanced communications and information processing systems for aircraft such as the Army's LHX (Comanche) helicopter, the Navy's A-12, and the Air Force's F-22 ATF; the Global Positioning System (GPS); Ground Mobile Forces SATCOM terminals and Jam-Resistant Secure Communications terminals for the Army and Air Force; and various HF, UHF, and VHF radio equipment. Harris' corporate strategy toward declining defense business includes efforts to expand into international military and commercial satellite applications. Because of its role as a supplier of high tech microelectronics subsystems and components, the company expects to maintain its defense business base, as many of its

products will be used to upgrade existing defense systems in lieu of new-start programs. [Ref. 19]

10. Honeywell Incorporated

A member of the electrical equipment industry, Honeywell is a worldwide manufacturer and marketer of control systems and components for use in its three business sectors: homes and buildings (44% of '94 sales); industrial (30%); and space and aviation (24%) [Ref. 76: p. 1012]. As part of its corporate strategy to reduce its dependence on weapons markets, the company divested its Defense and Marine Systems businesses in '89-'90, thereby setting a goal of relying on Government contracts for less than 15% of its sales. Key defense systems include(d): the MK-46 and MK-50 torpedoes; the Sense and Destroy Armor (SADARM) precision munition; the 120mm ammunition for the M1 tank; the AT-4 dismounted antitank weapon; the Combined-Effects Munitions (an air-delivered, free-fall cluster munition); cockpit displays, air data computers, electronic flight controls, and a flight management systems for the Air Force C-17; avionics and flight management systems for the F-15 fighter and the CH-47 Chinook helicopter; helmut-mounted displays, flight controls, cockpit displays and an integrated avionics suite for the Army Apache helicopter; the Army's Volcano modular mine dispensing system; and the Embedded GPS Inertial Navigation System for military aircraft. Despite declining defense budgets, Honeywell management is expecting the need for its products to remain stable. The company is targeting profitable growth in military business by focusing its efforts on: cost control, global retrofit market for aging aircraft, and taking a leading role in converting commercial avionics applications to military uses. [Ref. 21]

11. International Business Machines Corporation

A member of the computer and peripherals industry, IBM is the world's largest supplier of advanced information processing products, including computers and microelectronic technology, software, networking systems and information technology-related services. The company operates the following business segments:

hardware (51% of '94 revenues); software (18%); maintenance (11%); services (15%); and rentals and financing (5%). Foreign business accounted for 52% of IBM's '94 revenues. [Ref. 76: p. 1096] In '92 IBM formed a business unit known as the Federal Systems Company (FSC) by consolidating Federal Systems (which marketed specialized products and services to defense and other Government agencies) and Federal Systems Marketing (which offered commercially-available IBM products to Government agencies). However, FSC was divested to Loral in January, '94 in a strategic move to "right size" IBM by eliminating assets and expenses not fundamental to its core business. This, and other divestitures, were brought on by three consecutive years of loss. Although Federal Systems Marketing was not sold during the divestiture to Loral, IBM no longer sells Government customer-unique systems. [Ref. 22]

12. ITT Corporation

Value Line classifies ITT as a diversified industry participant. The company operates the following business segments: insurance (50% of '94 operating profits); automotive parts (20%); defense and electronics (5%); hospitality and entertainment (10%); fluid technology (6%); and communications and information services (9%, principally international Yellow Pages directories). [Ref. 76: p. 1372] Key defense systems include(d): the SINCGARS tactical radio; the AN/ALQ-165 Airborne Self-Protection Jammer (ASPJ) system for F/A-18 fighter aircraft; the Army's Advanced Threat Radar Jammer (ATRJ); the AN/AVS-6 Aviator's Night Vision Imaging System, and the AN/PVS-7 Night Vision Goggles; the AN/SPS-48E air search radar system; the AN/ALQ-172 Electronic Countermeasures system for use by the special operations C-130 fleet; and the Integrated Data Transport System (IDTS). During '94, ITT Defense and Electronics increased its income by 52% over the previous year, as sales grew due to successful implementation of its corporate strategy toward the defense industry: increase international defense sales; introduce defense technologies into civilian markets; focus on new product development; and restructure to reduce unnecessary costs. [Ref. 23]

13. Litton Industries Incorporated

Value Line classifies Litton as a member of the aerospace/defense industry. U.S. Government sales were 73% of '94 revenues. [Ref. 76: p. 564] Litton is a leader in the high-tech markets of navigation; guidance and control; electronic warfare; and command, control, and communications. It also manufactures, overhauls, repairs, and modernizes large multi-mission surface combat ships for the Navy. Prior to '93, the company operated in three business segments: advanced electronics; marine engineering and production; and industrial systems and products/services. As part of the corporate strategy to devote all management concentration and financial resources to building a stronger aerospace/defense business, the latter business unit was spun-off to shareholders in '93. Key defense systems include(d): the Aegis guided missile cruiser; the Navy's LHD amphibious assault ships; overhaul of selected destroyers (with vertical launch missile systems) and submarines; Tactical Air Operations Modules (TAOC) and Modular Control Equipment (MCE) for Air Force and Marines command, control, and communications; the AN/ALR-67 and AN/ALR-56M airborne threat radar warning system for attack and fighter aircraft; second generation laser gyro systems used in the Apache Longbow and Comanche helicopters; electronic warfare and inertial navigation systems for the Navy A-12; and avionics for the Air Force F-22. The corporate strategy of focusing all efforts on defense business was further manifested by the January '94 formation of Western Atlas, a new independent public corporation for Litton's commercial business. [Ref. 26]

14. Lockheed Corporation

Until '93, Lockheed was already a major player in the aerospace/defense industry, with 64% of its '93 sales to DoD customers. However, in '94 the company shocked the financial world when it merged with fellow defense industry giant Martin Marietta to form the world's largest aerospace/defense company -- Lockheed Martin. Through '93, Lockheed operated in various combinations/reorganizations of the following four business segments: aeronautical systems; missiles and space systems; electronic systems; and

technology services (formerly information systems). Lockheed segregated its customers into three groups: U.S. Government, foreign Government, and commercial. From its '87 high of 90%, Lockheed's Government sales steadily decreased to its '93 low of 77%. Similarly, its defense sales declined from 83% to 64% over this same period. Key defense systems include(d): the F-22 ATF (with Boeing and General Dynamics); the F-117A Nighthawk stealth fighter; the C-130 and C-5B strategic airlift aircraft; the P-3 Orion antisubmarine warfare patrol aircraft; the Navy's Trident fleet ballistic missile program; the MILSTAR military communications satellite program; Strategic Defense Initiative (SDI) program development; engineering and technical support for the Army's White Sands Missile Range and Dugway Proving Grounds test facilities; and the Army's Theater High Altitude Area Defense System (THAAD). One cannot discuss Lockheed's contribution to the DoD without mention of its "Skunk Works" advanced development company, a renowned industry leader in creating innovative aeronautic technology. In '92, as a move to strengthen its position in the defense segment, Lockheed purchased General Dynamics' aircraft business which included the F-16 aircraft. This acquisition also provided Lockheed a robust component of international business through F-16 sales to allied nations. As a result of this purchase, the company anticipated its business mix to shift from 67% to about 55% in U.S. defense sales, while total sales continued to grow. Its '93 corporate strategy consisted of five elements: (1) focus on core business to sustain the corporation; (2) maintain premier technology which distinguishes Lockheed from its competitors; (3) enter related markets to develop a more balanced business base; (4) capitalize on acquisitions which enhance technical and financial strength; and (5) reduce costs to improve competitiveness. In support its strategic pillar of seeking new non-defense markets, Lockheed entered into two business ventures in '93. First, an agreement with Motorola to launch the satellites for its IRIDIUM commercial communications satellite network. Secondly, Lockheed established a foothold in the commercial space launch market when it entered into a joint venture with two Russian companies (Khrunichev and Energia). The Russian companies will provide the Proton

booster while Lockheed provides the payload launch vehicle and markets the operation. [Ref. 27]

15. Loral Corporation

Value Line also reports Loral as an aerospace/defense company. Loral is a high-tech company specializing in defense electronics, telecommunications, space, and systems integration. About 80% of the company's '94 sales were to U.S. Government customers. [Ref. 76: p. 567] Since '86 Loral has restructured from strictly a defense electronics business to one that operates in the following broad business segments: defense- sectors include electronic combat, training & simulation, tactical weapons, and command, control communications & intelligence (C3 I)/reconnaissance; systems integration; and telecommunications and space. Key defense systems include(d): various aircraft self-protection devices such as the ALR-56, ALQ-131, ALQ-178, ALQ-157, ALQ-123, ALE-39, AAR-47; flight simulators for the F-4, E-2, A-6, F-15; the Multiple Integrated Laser Engagement Systems (MILES) laser-based training simulation system; the Army's Close Combat Tactical Trainer (CCTT) for the M1 tank; the Rotodome antenna for AWACS aircraft; the AIM-9M/P & R Sidewinder missile; the NITE Hawk Forward Looking Infrared (FLIR) targeting system for the F/A-18; the Chaparral mobile air-defense system for the Army; Vertical Launch Anti-Submarine (VLA) rockets for Navy guided missile cruisers and destroyers; the Army's Maneuver Control System (MCS); the Line-of-Sight Antitank (LOSAT) weapons system; the Extended Range Interceptor (ERINT) missile; the Multiple Launch Rocket System (MLRS) and Army Tactical Missile System (ATACMS); the Marine Corps' Predator short-range antitank weapon; the Navy's Light Airborne Multipurpose System (LAMPS) MKIII antisubmarine warfare helicopter; and the Army's Command and Control Vehicle (C^2 V). Loral's two principal strategic thrusts in dealing with the defense drawdown are: to maintain leadership in key military technologies by leveraging research and development investments in core business while continuing to improve its low-cost productivity; and to acquire valuable defense-related companies whose availability is the result of the industry's consolidation.

The latter strategy manifested itself in the following acquisitions: Goodyear Aerospace ('87); Electro-Optic Division of Honeywell ('89); a 51% stake in Ford Aerospace ('90); LTV's Missiles business unit ('92); and IBM's Federal Systems ('94). [Ref. 29]

16. The LTV Corporation

Listed as an integrated steel manufacturer in Value Line, LTV is the nation's third largest steel producer. The company emerged from seven years of bankruptcy protection in June, '93. [Ref. 76: p. 1412] With the '92 selling off of the company's Air Products, Missiles, and AM General Divisions, LTV ceased to be in the aerospace/defense business. LTV now operates in two business segments: (1) the steel segment which produces a diversified line of carbon steel products consisting of hot rolled and cold rolled sheet, galvanized, tin mill and other flat rolled coated products, tubular products and iron ore mining; and (2) the energy products segment which manufactures and sells oil and gas drilling equipment, oil field supplies, and industrial supplies. While in the defense industry, the company's key defense systems included: the Army Tactical Missile System (ATACMS) artillery weapons system; the High Mobility Multipurpose Wheeled Vehicle (HMMWV or "Hummer"); rockets and launchers for the MLRS; sections/components of the B-1B, B-2 and C-17 aircraft; the Sense and Destroy Armor (SADARM) warhead for the MLRS; the Line-of-Sight Antitank (LOSAT) weapons system; and the Extended Range Interceptor (ERINT) missile system. Although currently solvent and profitable, LTV gives no indication of reentry into the defense industry. [Ref. 30]

17. Martin Marietta Corporation

Until '93, the company was already a major player in the aerospace/defense industry, with 67% of its '93 sales to DoD customers. However, in '94 the company shocked the financial world when it merged with fellow defense industry giant Lockheed to form the world's largest aerospace/defense company -- Lockheed Martin. Through '93, Martin Marietta operated in various combinations/reorganizations of the following four business segments: electronics (41% of '93 sales); space (36%); information systems

(13%); and materials (5%). Key defense systems include(d): the Titan IV rockets; the Peacekeeper Intercontinental Ballistic Missile (ICBM) system; the Small ICBM program; SDI programs; the TADS/PNVS electro-optical navigation and targeting system for the AH-64 Apache helicopter; laser guidance system for the Hellfire missile; the Low-Altitude Navigation and targeting system (LANTIRN) for the F-15 & F-16; the Copperhead laser-guided artillery shell; components of the Patriot missile system; the Army's Pershing II intermediate-range missile program; components of the B-1B; advanced electro-optical systems for the Comanche helicopter; the Advanced Antitank Weapon System- Medium (AAWS-M), later renamed the Javelin, shoulder-fired infrared missile system (joint venture with Texas Instruments); the Vertical Launching System (VLS) antiaircraft, surface and submarine missile systems aboard Navy cruisers and destroyers; the Mark 50 antisubmarine torpedo; and GOCO management of the Milan Army Ammunition Plant. Martin Marietta's corporate "Peace Dividend" strategy called for: (1) growing the company's share of the defense market through cost competitiveness, technology advances, and exploitation of acquisition and consolidation of defense business units; (2) continued expansion into closely related civil Government and commercial markets; (3) and enhancing share value by maintaining a strong balance sheet and pursuing avenues that promise good returns to stockholders. This strategy was manifested in the '93 combination (although GE reports its selling) with GE Aerospace, and the '94 purchase of General Dynamics' Space Systems Division. The GE Aerospace deal was expected to enable Martin Marietta to consolidate facilities in order to reduce its capacity by approximately five million square feet. [Ref. 32]

18. McDonnell Douglas Corporation

Prior to the aforementioned formation of Lockheed Martin, McDonnell Douglas was, in terms of dollar amounts of contracts, the number one defense contractor. Its '94 customer base consisted of 62% Government sales. The company remains the world's largest builder of military fighter and transport aircraft; the third largest commercial aircraft maker; and a leading producer of helicopters, missiles, and satellite launch

vehicles. The company currently operates four business segments: military aircraft; commercial aircraft; missiles, space and electronics systems; and financial services. The company's commercial aircraft include the MD-80, MD-90, MD-11, and KC/DC-10 airliners. Key defense programs include(d): the F-15 Eagle, F/A-18 Hornet, AV-8B Harrier fighter aircraft; the C-17 transport aircraft; the AH-64 Apache attack helicopter; the now canceled A-12 aircraft program; the T-45 Goshawk trainer aircraft; the Harpoon anti-ship missile; the Delta II rocket; the Dragon shoulder-fired antitank weapon; co-production of the Tomahawk cruise missile; the Standoff Land Attack Missile (SLAM); and the Mast Mounted Sight electro-optical system mounted on the OH-58D helicopter. Corporate strategy toward the defense drawdown is a "here we stand" strategy based on what it perceives to be unique strengths as an aerospace company. The company has no intention of diversifying into new and unfamiliar business. Unlike its aerospace industry competitors, McDonnell Douglas has chosen not to rely on consolidation and merger to tackle the problems of excess capacity and decreasing demand. Instead the company has reduced capacity directly by closing four major fabrication plants, and making better use of remaining facilities. The company further indicates that it has not attempted to buy military aircraft market share because it already has it. Indeed, the company is the prime contractor for 46 of the 55 fixed-wing aircraft ordered by the U.S. Government in the FY 95 defense budget. Further, the company believes the upgrading of its aircraft to be a cost-effective alternative to new systems development. [Ref. 33]

19. Motorola Incorporated

According to Value Line, the company is a member of the semiconductor industry. Motorola operates predominantly in the wireless communications, semiconductor technology, and advanced electronics industry segments. Product line includes two-way radios, pagers, cellular telephones and systems; semiconductors (including integrated circuits and microprocessor units); data communication and distributive processing equipment and systems; and electronic equipment and industrial electronic products. [Ref.

76: p. 1067] Only 44% of the company's '94 sales were to U.S. customers. Almost all of the firm's Government business is conducted by the Government and Space Technology Products (formerly Government Electronics) business unit, which has declined steadily from 9% of total sales in '86 to 4% in '94. Key defense products and systems include(d): FMU-139/B and FMU-140 fuses and FZU-48 generators supporting Air Force and Navy requirements; the FZU-93/B proximity sensor used on the Combined Effects Munitions System; the MK-45 target detection devices for the Navy's Standard Missile; Navy UHF Demand Assigned Multiple Access (DAMA) units, and electronic maintenance components; a down-sized Ground Station Module for the Joint Surveillance Target Attack Radar System (JSTARS); the Secure Telephone Unit III (STU-III); the Navy's Automatic Carrier Landing System (ACLS); the Future Secure Voice System (FSVS); the KG-94A digital encryption/decryption device; the Lightweight Satellite Terminal (LST-5C); and the 21st Century Land Warrior Generation II Soldier system. The company attributed steadily declining sales in the Government business segment to defense programs being scaled back or drawn out. In '86 the company was concerned with controlling the excessive costs to comply with Government regulation and oversight. The strategy in '87 was to reduce cycle time in order to improve productivity and lower costs. This productivity improvement strategy was designed to improve competitiveness in the company's core businesses while penetrating related new domestic and international markets with commercial business potential. [Ref. 35]

20. Northrop Corporation

An aerospace/defense company, over 88% of Northrop's '93 sales were to the U.S. Government. In '94 the company merged with a competitor, the Grumman Corporation, to form Northrop Grumman. Government sales for the new merged company were 85% of '94 sales. The company operated in four industry segments: aircraft; electronics; missiles and unmanned vehicle systems (MUVS); and services. Northrop commercial aircraft business provided fuselages for the Boeing 747 airliners. Major defense systems include(d): the B-2 stealth bomber; guidance systems for the MX and AMRAAM missile

systems; subcontractor to McDonnell Douglas for several components/sections of the F/A-18; the AGM-136A Tacit Rainbow missile vehicle (an aerial radar-searching drone); electronic countermeasures systems such as the AN/ALQ-135, 161, 162 and 171 for use on numerous attack and bomber aircraft; the Tri-Service Standoff Attack Missile (TSSAM) program; and the BAT "brilliant" anti-armor submunition. Prior to the '94 merger, Northrop's corporate strategy was to remain a significant part of the U.S. defense technology base while expanding its commercial aircraft structures business. The strategy was brought about by the company's belief that it has and will continue to anticipate aerospace customer requirements in a post Cold War environment. Northrop further rationalized this strategy by believing its product line to compliment the emerging defense need for long reach, quick-strike, survivable, standoff, precision weapon systems. [Ref. 40]

21. Raytheon Company

Although classified as an aerospace/defense firm, Raytheon produces a diverse variety of products. Prior to '94, the company was organized into the following four business segments: electronics (41% of '94 sales); aircraft products (17%); major appliances (14%); and energy (and environmental) services. In '94, the latter business unit was replaced by a segment reported as engineering and construction which produced 28% of Raytheon's '94 sales. Over the period of '86 to '94, the company's customer base has gone from 53% Government (including foreign military sales) and 47% commercial, to 35% Government and 65% commercial. Its commercial products include: corporate jets and turboprop jets; and home appliances under the brand name Amana, Caloric, and Speed Queen. Key defense systems include(d): the Patriot, Hawk, Sparrow, Sidewinder, Maverick, Standard Missile-2, Phoenix, and AMRAAM missiles; electronic countermeasure systems such as the AN/ALQ-99, 142, 184, and AN/SLQ-32; the Navy's Extremely High Frequency (EHF) SATCOM Program (NESP); key elements of the Aegis defense system aboard Navy cruisers and destroyers; the C-12 operational support and utility aircraft; aerial missile targets such as the AQM-37, BQM-126, MQM-107;

mine-hunting sonar systems such as the AN/SQQ-32 and AN/SQS-20; the AN/TRC-170 troposcatter radio system; Air Force Military Strategic Tactical and Relay (MILSTAR) terminals; computer systems for JSTARS; composite winglets and landing gear doors for the C-17; and the Ground Based Radar for the THAAD missile defense system. Raytheon plans to remain a formidable competitor in defense during existing and future periods of intensified competition and lower defense spending. To meet this objective, the company has restructured its operation by consolidating all missile manufacturing into a single facility, and consolidating all defense-related business units into the Raytheon Electronics Systems Division. Additionally, Ratheon plans to continue to apply defense technologies in those commercial markets where a strong match exists between the company skills and existing and emerging global opportunities. Two examples of promising dual-use technology development are infrared imaging technology, and optical phased array radar technology. [Ref. 45]

22. Rockwell International Corporation

Another aerospace/defense firm, Rockwell is a diversified high tech company with leadership positions in global markets. In '94, 65% of Rockwell's sales were to its U.S. and international commercial customers, and only 35% to the U.S. Government (DoD 20%, NASA 15%). The company's customer base has changed radically over the past ten years, as its sales to DoD customers have decreased by 49%, and sales to NASA, U.S. commercial, and international customer sales have increased 17%, 133%, and 249% respectively. In '84 DoD business accounted for over one half of corporate sales, whereas in '94 it accounted for only one fifth of total sales. Over the same period, Rockwell has also undergone a shift in its product line, as its aerospace sales have decreased by 39%, while its automotive, graphic systems, and electronics business segment sales have increased 65%, 119%, and 145% respectively. The company currently operates in seven industry segments: automation, avionics, telecommunications, defense electronics, aerospace, automotive, and graphic systems. Most of its U.S. Government business is conducted in the aerospace and defense electronics segments. Key defense systems

include(d): the B-1B bomber aircraft (prime contractor); the Peacekeeper ICBM; the NAVSTAR GPS satellite; Hellfire missiles; conversion of C-130 cargo aircraft to AC-130U gunships; SDI programs; the Automatic Target Handover System for the Apache helicopter; Very Low Frequency (VLF) strategic communications equipment; the Air Force's AGM-130 and GBU-15 standoff weapon systems; inertial navigation systems for attack and ballistic missile submarines; the Joint Tactical Information Distribution System (JTIDS); drive axles for many Army heavy vehicles; teamed with Lockheed on THAAD program; the MILSTAR communications satellite command posts; and the Secure Mobile Anti-jam Tactical Terminals (SMART-T) for MILSTAR tactical ground users. The company's strategic focus has been to become a leader in the global marketplace. Rockwell has attained a more balanced mix of high-tech commercial and defense/aerospace business. [Ref. 46]

23. Tenneco Incorporated

Value Line reports Tenneco as a member of the natural gas industry. It is a holding company whose subsidiaries in the following diversified business sectors: natural gas (20% of '94 revenues); automotive parts (16%); packaging (18%); shipbuilding (14%); and farm and construction equipment (32%). [Ref. 76: p. 469] The firm's defense business is conducted by its Newport News Shipbuilding (NNS) subsidiary. Since '86, when Shipbuilding was 12% of sales, this line of business has been a steady contributor to corporate profits. NNS designs, builds, repairs, refuels, and overhauls U.S. Navy aircraft carriers, other surface ships, and submarines. It also builds, repairs, and overhauls commercial ships. Although NNS has been relatively unaffected by defense drawdowns, its key strategies for continued success are: (1) to protect its core business of Navy nuclear work while aggressively pursuing other Naval opportunities in ship construction, refueling, overhaul, repair, and nuclear engineering; (2) to build new business in commercial markets; and (3) to continue to reduce costs by consolidating and simplifying work processes. [Ref. 50]

24. Texas Instruments Incorporated

As a member of the semiconductor industry, TI manufactures electronic products based principally on its semiconductor technology. The company operates in four industry segments: components (65% of '94 sales); defense electronics (17%); digital products (16%); and metallurgical materials (2%). Nearly all of the firm's DoD business is conducted with the defense electronics business segment, which has steadily declined since '86 when its sales were over 34% of total sales. Defense programs include(d): terrain following radars for the LANTIRN program; Thermal Imaging Systems for the Chaparral air defense system; phased array radar for the F-22 ATF; the focal plane array for the Javelin/AAWS-M shoulder-fired antitank weapon; the High-speed Anti-radiation Missile (HARM); the Navy's Advanced Interdiction Weapon System (AIWS); and the Army's Improved Target Acquisition System (ITAS). As early as '86, TI recognized the opportunities brought on by the defense drawdown. The realities of fewer new-start programs and a trend toward a higher electronics content of existing defense systems favor high-tech companies like TI. One aspect which favors TI's strength in defense markets is the fact that many of its products are used and expended in "smart" weapons. As a result of the Gulf War, not only are such weapons in high demand, but their stocks needed to be replenished. TI hopes to benefit accordingly. [Ref. 51]

25. Textron Incorporated

Value Line reports Textron as a diversified industry participant, with products and services such as: helicopters, turbine engines, airframe parts, consumer lending, insurance, and auto parts. Its '94 U.S. Government sales were 20% of corporate totals. [Ref. 76: p. 1396] Textron operates five business segments: aircraft (23% of '94 revenues); automotive (16%); industrial (14%); systems and components (16%); and financial services (31%). The company's Government business is conducted by the aircraft and systems and components business segments. In '90, the company's commercial aerospace business overtook its defense aerospace business both in terms of sales and profit. Key

defense systems include(d): teamed with Boeing on the V-22 Osprey tilt-rotor aircraft; gun turret drives, stabilization systems, and turbine engines for the M-1 Abrams tank; Army Cobra attack and Kiowa Warrior scout helicopters; the Landing Craft Air Cushioned (LCAC) amphibious assault craft; systems for the Peacekeeper MX missile; wings for the B-1B bomber and C-5B cargo aircraft; and the TH-67 Creek training helicopter. Textron's strategy towards its defense aerospace business is to continue to diversify into more commercial aerospace business. As part of this strategy, in '92 the company purchased Cessna, a leading producer of small commercial jet aircraft. While this acquisition serves to reduce Textron's reliance on business from the DoD, the company expects DoD to rely more on Textron for more affordable upgrades of existing helicopter systems in lieu of expensive new start programs. [Ref. 52]

26. Unisys Corporation

Listed in Value Line as a computer and peripherals manufacturer, Unisys designs and produces these products and services for a variety of domestic and foreign commercial and Government customers. Foreign customers accounted for 51% of '94 sales. [Ref. 76: p. 1115] The company is broken down into three business segments: equipment sales (including enterprise systems and servers, departmental servers and desktop systems, software, and custom defense systems) (55% of '94 revenues); information services and systems integration (27%); and equipment maintenance (18%). The firm's defense business is conducted by the custom defense systems business unit of the equipment sales segment, and it was responsible for 16% of '94 corporate sales. Defense programs include(d): the navigation system for the Trident II nuclear-powered submarine; integration of fire control, weapons, and electronics systems aboard Navy frigates; the AN/UYK-43 and 44 computers used aboard Navy vessels; the combat subsystem of the Seawolf submarine; the Marine Air Traffic Control and Landing System (MATCALS); the AEGIS combat system; and the AN/TRC-170 troposcatter microwave communications system. Its '94 strategy toward defense business was: (1) to leverage and diversify defense skills and technologies for growth in selected public sector and commercial markets; and

(2) to emphasize open systems and dual-use technologies. However, with the company's recent announcement of an agreement to sell its defense segment business to Loral, it appears to have abandoned defense industry participation entirely. [Ref. 74]

27. United Technologies Corporation

A manufacturer of a highly diversified product line, the company operates in the following business segments: Otis (22% of '94 revenues) produces elevators and escalators; Carrier (23%) produces air conditioning equipment; Automotive (13%) produces electrical and electo-mechanical products for the auto industry; Pratt & Whitney (27%) produces aircraft engines; and Flight Systems (15%) which produces helicopters, rocket motors, and fuel and environmental control systems. Its key defense systems include(d): the F-404 engine for the F/A-18; the F-100-PW-220 and 229 engines for the F-15 and F-16; the F-117 engine for the C-17; the F119 engine for the F-22 ATF; the T-406 engine for the V-22; the T-800 helicopter engine; the RL-10 rocket engine used on the Titan IV; the Sea Dragon, Blackhawk, Seahawk, and Super Stallion helicopters; the A-6F radar system; the J-STARS radar system; and the Multi-Mode Radar System (MMRS); and teamed with Boeing on the RAH-66 Comanche helicopter program. Globalization remains the company's top strategic priority. To carry out this strategy, the company is marketing its products internationally through overseas business alliances. Attesting to the company's successful diversification efforts, its Government sales have leveled off over the past decade, while its commercial sales have grown steadily. [Ref. 75]

28. Westinghouse Electric Corporation

Although classified by Value Line as a member of the electrical equipment industry, Westinghouse is a diversified, global, technology-based corporation operating in the principal markets of: television and radio broadcasting (10% of '94 sales); defense electronics (29%); environmental services (4%); transport refrigeration (Thermo King subsidiary, 10%); and electric utilities (Power Generation business unit, 19%); and nuclear power plant services (Energy Systems Group, 14%) [Ref. 76: p. 1020]. Defense business

is conducted primarily in the Electronic Systems Group. The company's defense programs include(d): the radar system for F-16 fighter aircraft; the AWACS radar system; F-22 avionics; the launch system for the sea-launched Tomahawk cruise missile; the MK-48 and 50 torpedo programs; radars for the Navy's A-12 aircraft and the Army's Apache Longbow helicopter; Navy Airborne Self-Protection Jammers; the AN/SQQ-89 Antisubmarine Warfare System; and weather radars for the C-130. Westinghouse's Electronic Systems Group's strategy during declining defense budgets includes: (1) to grow existing core businesses through program extensions, retrofits of existing systems and transitions onto new platforms, such as ships, aircraft and satellites; (2) extend its strong DoD and Federal Aviation Administration (FAA) products to key international markets; and (3) expand its business base through selected U.S. and international acquisitions and joint ventures. The Group's goal (expected to be reached in '95) is to diversify its business base such that half of its sales come from DoD customers and half are from non-DoD customers. [Ref. 78]

D. DATA COLLECTION AND SYNTHESIS

Data were collected primarily from the annual reports of the sample companies. Although to varying degrees, all 28 companies responded to a telephonic request for financial statements. After repeated phone calls over a one month period, all but two companies (Boeing and IBM) provided all requested data. Since these companies each provided only three of the requested nine annual reports, the data were supplemented by *Standard and Poor's Industry Surveys* where available. As noted earlier, data collection was complicated by the lack of a standard format for consolidated balance sheets and income statements. After weeding through the notes to the financial statements and applying some judgment, the data in the following table were collected from the sample contractors for the duration being studied:

Balance Sheet Items	Income Statement Items
Total Liabilities	Net Sales
Total Equity (Current & Previous Year)	Cost of Goods Sold
Current Assets	Interest Expense
Current Liabilities	Income Taxes
Total Assets (Current & Previous Year)	Income Before Taxes
Inventory (Current & Previous Year)	Effective Tax Rate
Accounts Receivable (CY & PY)	Net Income

Table 2-2. Financial Statement Data Items.

These data were entered into a series of Lotus 1-2-3 spreadsheets which computed the eight ratios used in this thesis. The ratios were then organized/compiled and synthesized into various groups to facilitate statistical computations and graphical displays for the thesis analysis.

As previously stated, financial ratios are useless unless they are compared with the same ratios of other firms or compiled industry ratio averages. Since the analysis required a comparison between ratio values of the sample defense firms and industry ratio averages, selected averages were collected from Dun & Bradstreet's (D&B) *Industry Norms & Key Business Ratios*. This reference reports ratio values by Standard Industrial Classification (SIC) codes which will be discussed below. D&B provided the median (AKA the Norm), upper quartile (UQ), and lower quartile (LQ) values for the following ratios: current ratio, collection period, debt to equity, and return on assets. This reference also provided an average (mean) value for the ratio of working capital to total assets. These data were also entered into spreadsheets for statistical computation and graphical presentation.

Because the above reference provided comparative industry average ratio values according to SIC codes, the sample firms were segregated by the SIC codes which corresponded to their various lines of business. Based on line of business information provided to the Census Bureau by U.S. firms, the Office of Management and Budget produced the *Standard Industrial Classification Manual*. The SIC industry classification system divides economic activities into eleven broad industrial divisions, and subdivides each division into two-digit major groups, three-digit industry subgroups, and four-digit detailed industries. [Ref. 57] While the sample firms participated in a number of

industries, the industrial division of interest to this thesis was the Manufacturing Industry (major group SICs 20-39, and detailed industry/product SICs 2011-3999). A SIC analysis was conducted in order to determine which firms participated in which lines of business. The particular four-digit SICs (equating to lines of business in which each firm participated) were gleaned from the *Standard & Poor's Register of Corporations, Directors and Executives.*

Sample firms were not only segregated by lines of business or SIC, they were also separated according to their level of participation in the defense industry. The criteria used to group sample firms were: the Value Line industry classification of each firm; the amount of defense/Government business relative to commercial business; and strategy toward their existing and future participation in the defense industry. For instance, firms which are classified by Value Line as aerospace/defense firms; and/or receive a large portion of their sales revenue from DoD; and/or have adopted strategies which indicate a desire to remain competitive in the defense industry are classified as "defense-dependent" firms. On the other hand, those firms which Value Line classification, defense sales volume, and corporate strategies so indicate are classified as "defense-indifferent" firms. These groupings facilitated statistical analysis of the data.

E. COMPARATIVE ANALYSIS

1. Visual/Graphical Analysis

In order to evaluate the solvency, efficiency, and profitability of the sample firms, the ratio data were used to create a series of line charts displaying the value of all eight ratios for each firm over the entire period of study. These charts were used to display and evaluate trends and anomalies over the nine year period '86-'94. The charts and a brief evaluation of the financial ratios of each of the sample firms are presented in Chapter III of this thesis -- **DATA PRESENTATION**.

Similarly, line charts were used to visually display and evaluate sample defense contractor ratio values compared to industry averages or "norms" for these same ratios.

In order to create these charts, an analysis was conducted to determine the SICs in which sample defense contractors most often operated. As a result of this SIC analysis, and the availability of data on industry averages for various ratios and SICs, the following four-digit SICs were selected:

SIC	Short Title
3571	Electronic Computers
3577	Computer Peripheral Equipment, NEC
3661	Telephone and Telegraph Apparatus
3663	Radio & TV Communications Equipment
3669	Communications Equipment, NEC
3674	Semiconductors and Related Devices
3679	Electronic Components, NEC
3699	Electrical Equipment & Supplies
3721	Aircraft
3728	Aircraft Parts and Equipment, NEC
3812	Search and Navigation Equipment
3829	Measuring & Controlling Devices, NEC

Table 2-3. Four-Digit SICs Used for Visual/Graphical Analysis.

The ratios used for this portion of the analysis were: current ratio, collection period, debt to equity, and return on assets. These ratios are common to this thesis and D&B's *Industry Norms & Key Business Ratios.* The UQ, LQ, and median (referred to as the industry "norm") values obtained from this reference, along with the median ratio values of participating sample firms, were plotted on line charts for graphical presentation. The sample median of each of the 12 SICs was selected from among only those sample firms which conducted business within the given category. Industry norms (or medians), UQs and LQs for selected SICs are derived from the Dun & Bradstreet Financial Data Base which contains data from over one million financial statements. This data base contains financial data from U.S. firms in over 800 lines of business, and is used to produce the desk-top reference *Industry Norms & Key Business Ratios.* The industry norms in the D&B reference represent the mid-points from among all of the companies which participate in (i.e., manufacture products in this business line) the particular SICs and provide input to the D&B data base. For instance, financial data from 189

establishments were used to compute the industry norm, UQ and LQ values for various financial ratios for the SIC 3571 in 1988 [Ref. 6: '88-'89, p. 111]. The UQs and LQs represent the midpoint values of the upper and lower halves, respectively, of the participating D&B sample firms. Note however, the UQ figures are not always the highest numerical value, nor are the LQ figures always the lowest numerical values. Since these quartiles represent judgmental ranking, the UQ represents the best condition or ratio value, whereas the LQ represents the worst condition or ratio value. [Ref. 6] These charts are presented in Chapter IV -- **COMPARATIVE ANALYSIS** -- of this thesis, and indicate which conditions (numerically lower or higher values) are most desirable.

2. Statistical Tests

The quantitative analysis of this thesis consisted of statistical tests of a variety of hypotheses about the average (or mean) values of various ratios of the sample firms as compared to each other and to industry averages. The statistical concept of hypothesis testing allows researchers to assess the validity of some conjecture about an unknown population parameter based on data from a representative sample of the population. The population of interest in this thesis consists of all defense firms. If a sample is to be taken from a population, with the aim of making valid statements about the population at large, it is important that the sample be representative of that population. In order to prevent the selection of a sample which is unrepresentative of the population, statisticians often select samples randomly. However, the time required to request, receive, compile, and analyze the financial data for this thesis precluded the use of random sampling. As previously mentioned, the 28 sample defense firms, although not randomly selected, are representative of the defense industry population in that, over the period of study, they have conducted nearly one-half of all U.S. defense business.

Statistical hypotheses consist of several components which merit mention here. First of all, a **null hypothesis (H_0)** is a maintained position about various parameters that is held to be true unless sufficient evidence is presented to the contrary. When sample data are collected, this hypothesis is put in jeopardy, or **tested**. If the null hypothesis turns

out to by untrue, then some **alternative hypothesis (H_1)** must be true, and in conducting hypothesis testing, the researcher tests the null hypothesis against this alternative. Alternative hypotheses can be either **one-sided** or **two-sided** alternatives. A **one-sided** (or one-tailed) alternative hypothesis is one involving all possible values of a population parameter on either side of (i.e., either greater than or less than) the value specified by the null hypothesis. On the other hand, a **two-sided** (or two-tailed) alternative hypothesis involves all possible values of a population parameter other than (i.e., not equal to) the value specified in the null hypothesis. Once H_0 and H_1 have been established, and the sample data have been collected and computed, the researcher must make a decision regarding H_0. The data must support one of two possible decisions regarding the null hypothesis: to reject H_0, or to accept H_0 (or, more precisely, fail to reject H_0). However, since the true population parameter is unknown, whatever the decision regarding the null hypothesis, there is some chance of reaching an erroneous conclusion about the population parameter. There are only two possible states of nature -- either H_0 is true or it is false. One possible error, a **Type I error**, is the rejection of a true null hypothesis. The probability of committing a Type I error is known as the **significance level**. This probability is expressed as a percentage, and is represented by the symbol α. Since H_0 can either be accepted or rejected, it follows that the probability of accepting H_0 when it is true is $(1-\alpha)$. The most commonly used level of significance among researchers, and the value used in this thesis, is $\alpha=.05$. This means that in such a test of hypothesis, there is a 5% chance that the researcher will erroneously reject a true null hypothesis, and a 95% chance that he will accept a true null hypothesis. Finally, the particular statistical hypothesis testing method used in this thesis is the **t-test**. This technique gets its name from the test statistic ***t***, which researchers use to decide whether to accept or reject the null hypothesis, H_0. [Ref. 39] The various formulae and decision criteria for the t-statistic will be defined during the following discussion of t-tests.

A series of one-sample, one-sided t-tests of hypothesis were conducted to determine whether or not, with regard to selected financial ratios, the defense industry (as

represented by the sample firms) was either better off, the same as, or worse off than all manufacturing firms in selected industry groups. The financial ratios used for these tests were: the current ratio (CR), collection period (CP), and return on assets (ROA). A one-sample t-test is used to test an unknown mean against a standard. In this case, the unknown means of selected financial ratios for the entire defense industry were represented by the sample means of these ratios. These sample means are compared to industry norms or average ratio values for the following manufacturing industry groups depicted by their two-digit SIC codes: Fabricated Metal Products (34); Industrial Machinery and Equipment (35); Electronics and Other Electric Equipment (36); Transportation Equipment (37); Instruments and Related Products (38). Industry norms for the financial ratios of these two-digit industry segments were obtained from the '93-'94 and '94-'95 Desk-Top Editions of D&B's *Industry Norms & Key Business Ratios*. During thesis analysis, the following one-sample, one-sided t-tests were conducted for all five manufacturing industry groups for years '93 and '94:

- $H_0 : \overline{X}_{CR} \geq \mu_{CR}$ versus $H_1 : \overline{X}_{CR} < \mu_{CR}$; where $\overline{X}_{CR}$ is sample mean current ratio value; and μ_{CR} is manufacturing industry norm (average) current ratio. Reject H_0 if $t \leq -t_{\alpha,n-1}$; where $t = \frac{\overline{X}-\mu}{\frac{s}{\sqrt{n}}}$ with s being the sample standard deviation, and n referring to the sample size; and $t_{\alpha,n-1}$ referring to a tabular value representing a t-distribution for parameter comparison.

- $H_0 : \overline{X}_{CP} \leq \mu_{CP}$ versus $H_1 : \overline{X}_{CP} > \mu_{CP}$; where $\overline{X}_{CP}$ is sample mean collection period; and μ_{CP} is manufacturing industry norm collection period. Reject H_0 if $t \geq t_{\alpha,n-1}$.

- $H_0 : \overline{X}_{ROA} \geq \mu_{ROA}$ versus $H_1 : \overline{X}_{ROA} < \mu_{ROA}$; where $\overline{X}_{ROA}$ is sample mean ROA; and μ_{ROA} is manufacturing industry norm ROA. Reject H_0 if $t \leq -t_{\alpha,n-1}$.

These formulae and rejection criteria are appropriate when, as is the case with the entire manufacturing industry, the population variances are small relative to the sample variances. [Ref. 39]

Similarly, a series of two-sample, one-sided t-tests of hypothesis were conducted to determine whether or not, with regard to selected financial ratios, the defense-dependent firms within the sample were either better off, the same as, or worse off than the defense-indifferent firms within the sample. The financial ratios used for these tests were: the current ratio (CR); inventory turn over (ITO); and the gross margin ratio (GMR). A two-sample t-test is used to test for a significant difference between two sample means. In this case, the means of selected financial ratios, for the years '86-'94, for the defense-dependent firms are compared with those of the defense-indifferent sample firms for the same period. The following two-sample, one-sided t-tests were conducted for every year of the study, and the results (along with those of the one-sample tests) are presented in Chapter IV -- **COMPARATIVE ANALYSIS**-- of the thesis:

- $H_0 : \overline{X}_{CR} \geq \overline{Y}_{CR}$ versus $H_1 : \overline{X}_{CR} < \overline{Y}_{CR}$; where $\overline{X}$ represents the mean CR, ITO and GMR values for the defense-dependent sample firms, and $\overline{Y}$ represents the mean CR, ITO and GMR values for the defense-indifferent sample firms. Reject H_0 if $t \leq -t_{\alpha,\gamma}$; where $t = \frac{\overline{X}-\overline{Y}}{\sqrt{\frac{s_x^2}{nx}+\frac{s_y^2}{ny}}}$ with s_x^2 and s_y^2 being the sample variance of the defense-dependent and defense-indifferent firms respectively; and n_x and n_y being the sample sizes of the defense-dependent and defense-indifferent firms respectively. Again, the value $t_{\alpha,\gamma}$ refers to a comparison value found in a t-distribution table. However, depending on the similarity of the sample variances, γ , known as the *degrees of freedom*, is computed differently. This comparison value, as well as the test statistic *t*, was computed using Quattro Pro computer software.

- $H_0 : \overline{X}_{ITO} \geq \overline{Y}_{ITO}$ versus $H_1 : \overline{X}_{ITO} < \overline{Y}_{ITO}$; where the variables represent the mean ITO values for the sample firms as above. Reject H_0 if $t \leq -t_{\alpha,\gamma}$.

- $H_0 : \overline{X}_{GMR} \geq \overline{Y}_{GMR}$ versus $H_1 : \overline{X}_{GMR} < \overline{Y}_{GMR}$; where the variables represent the mean GMR values for the sample firms as above. Reject H_0 if $t \leq -t_{\alpha,\gamma}$.

III. DATA PRESENTATION

A. GENERAL

The purpose of this chapter is to present the financial ratio data for each of the sample firms over the nine year period of study. As previously stated, a graphical method is used in order to identify trends and outliers. Such a presentation of the data also allows the reader to compare and contrast the ratio values of various firms. The eight financial ratios are graphed according to financial condition grouping (i.e., solvency, efficiency, or profitability). Although collection period is classified as both a solvency and an efficiency ratio, it is presented only on the efficiency graphs. Where the magnitude of specific data elements are meaningless, notes on the graphs so indicate. This condition occurs in the following cases: two firms experienced negative equity (affecting DE and ROI); ten firms experienced negative working capital, whereby current liabilities were larger than current assets (affecting WCTA); and fourteen of the firms experienced losses of net income during the period of study (affecting ROA and ROI). In the legend of each graph, the letter "H" or "L" beside the ratio name indicates the more desired state of nature for the ratio, higher or lower respectively.

B. INDIVIDUAL DEFENSE FIRM FINANCIAL CONDITION

1. The Boeing Company

a. Solvency

Figure 3-1 displays Boeing's solvency ratios for the period of study. Although CR data were not available for '86-'87, the upward trend is a positive indicator of the firm's solvency. This position is reinforced by the downward trend in the

DE ratio. These trends indicate that the firm's current assets are growing relative to current liabilities, and its debt is shrinking relative to equity.

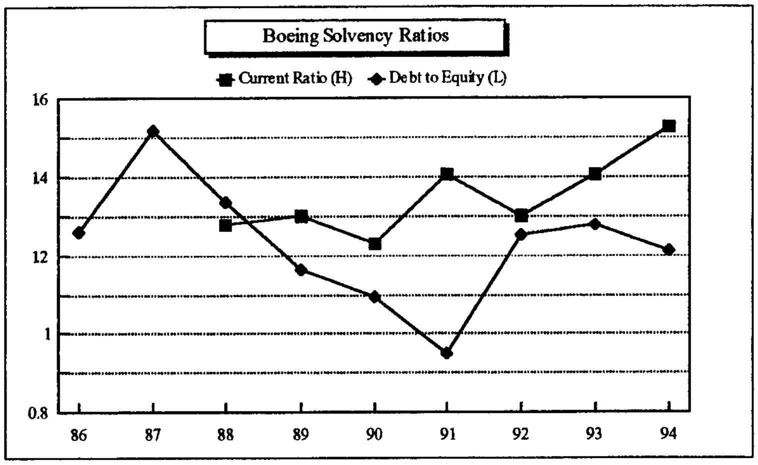

Figure 3-1. Boeing Solvency Ratios ('86-'94).

b. Efficiency

Figure 3-2 displays Boeing's efficiency ratios for the period of study. The firm's efficiency ratios give a mixed view of its operating efficiency. While the downward trend in CP is a positive sign, the downward trend in WCTA indicates lower efficiency over the period of study. The graph indicates shrinking working capital, and faster collection of receivables. The firm's ITO is stable.

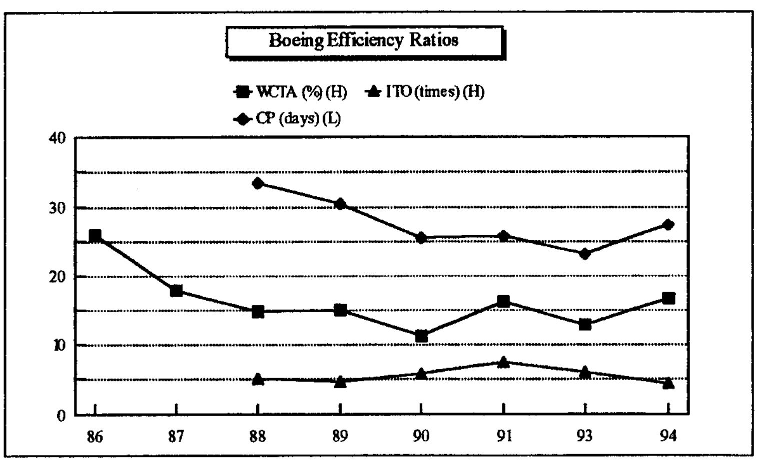

Figure 3-2. Boeing Efficiency Ratios ('86-'94).

c. Profitability

Figure 3-3 displays Boeing's profitability ratios for the period of study. Over this period, the firm's ROA and ROI increase to double their magnitudes only to return to their original modest values by '94. The firm's increasing GMR trend indicates increasing profitability.

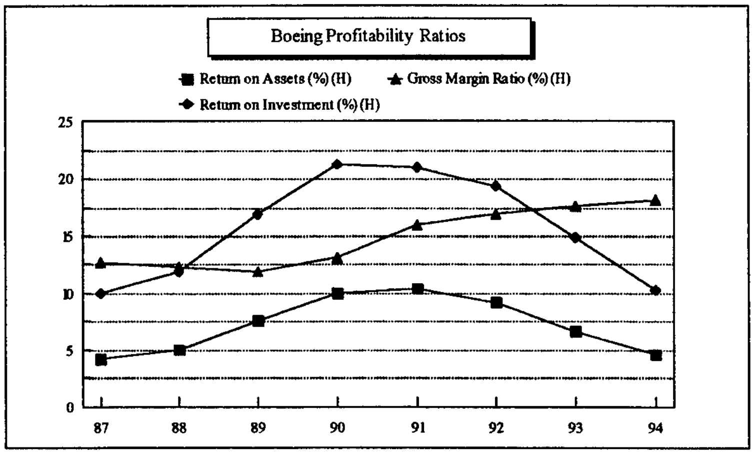

Figure 3-3. Boeing Profitability Ratios ('86-'94).

2. E-Systems Incorporated

a. Solvency

Figure 3-4 displays E-Systems' solvency ratios for the period of study. The graph shows an extremely solvent firm, in that its DE ratio is steady and less than one, and the trend for its CR is increasing.

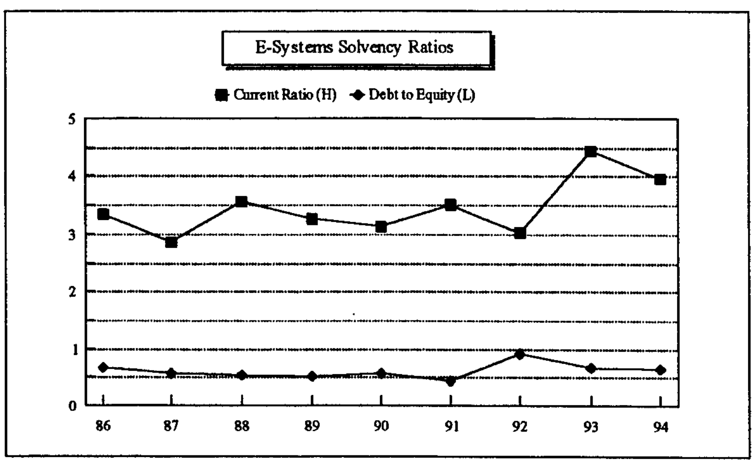

Figure 3-4. E-Systems Solvency Ratios ('86-'94).

b. *Efficiency*

Figure 3-5 displays E-Systems' efficiency ratios for the period of study. The graph shows a mixed picture of the firm's efficiency. While the WCTA appears relatively stable, both the CP and ITO increase steadily. The upward trend in CP is a sign of inefficiency in that the firm is slower to collect its receivables. However, the upward ITO trend indicates that the firm is becoming more efficient by turning its inventory over more frequently.

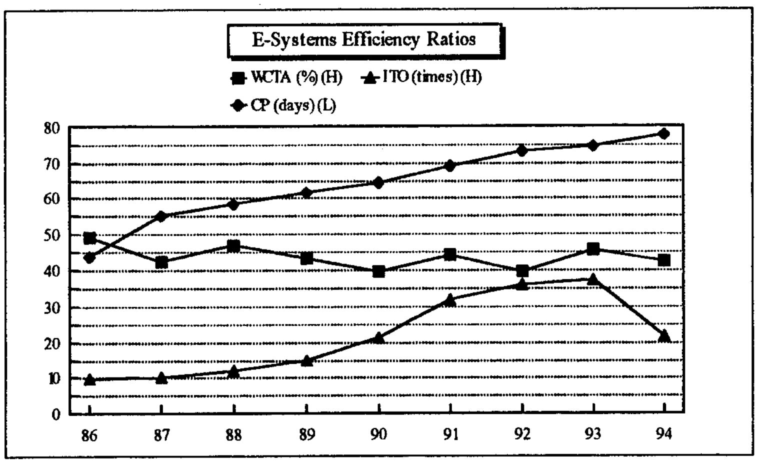

Figure 3-5. E-Systems Efficiency Ratios ('86-'94).

c. *Profitability*

Figure 3-6 displays E-Systems' profitability ratios for the period of study. While the downward trends in ROA and ROI indicate shrinking profitability, this position is somewhat offset by the fact that the GMR remains fairly stable.

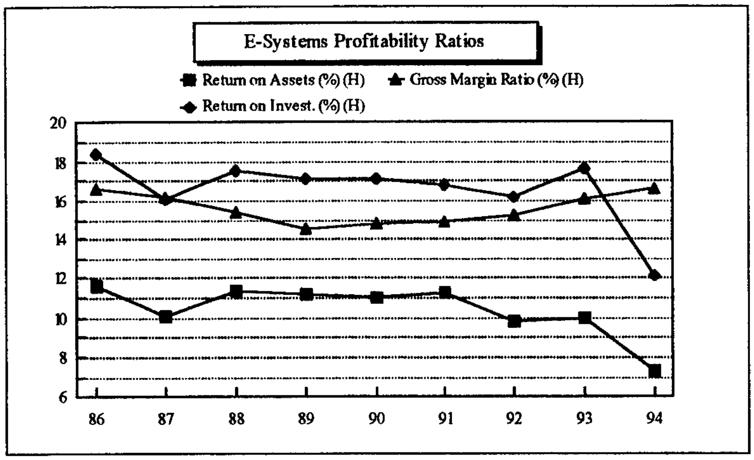

Figure 3-6. E-Systems Profitability Ratios ('86-'94).

3. FMC Corporation

a. Solvency

Figure 3-7 displays FMC's solvency ratios for the period of study. Indicative of extreme insolvency, the firm experienced an equity deficit from '86-'89. However, once positive equity was reestablished, the downward DE trend indicates increasing solvency, but the magnitude of the firm's debt offsets any such positive outcome. Although the firm's CR trend remains relatively stable, the magnitude (less than 2) might be considered less solvent.

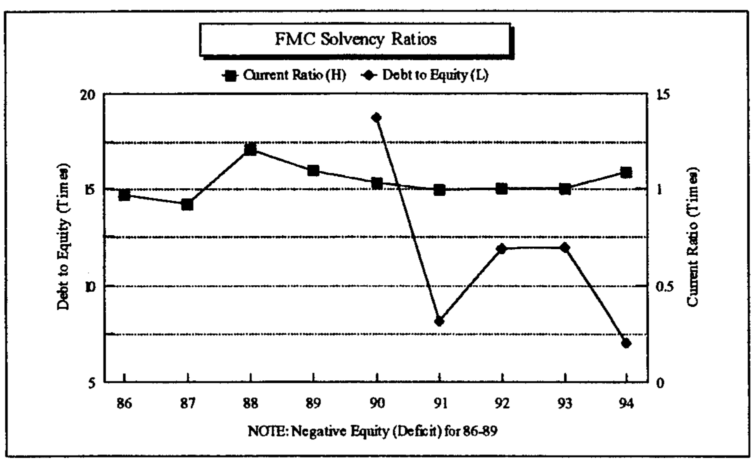

Figure 3-7. FMC Solvency Ratios ('86-'94).

b. Efficiency

Figure 3-8 displays FMC's efficiency ratios for the period of study. The negative working capital experienced by the firm during four years of the period, indicates inefficiency. The upward CP trend also indicates inefficiency as the firm has become slower to collect its receivables. However, the upward ITO trend indicates the firm's increasing efficiency at turning over its inventory.

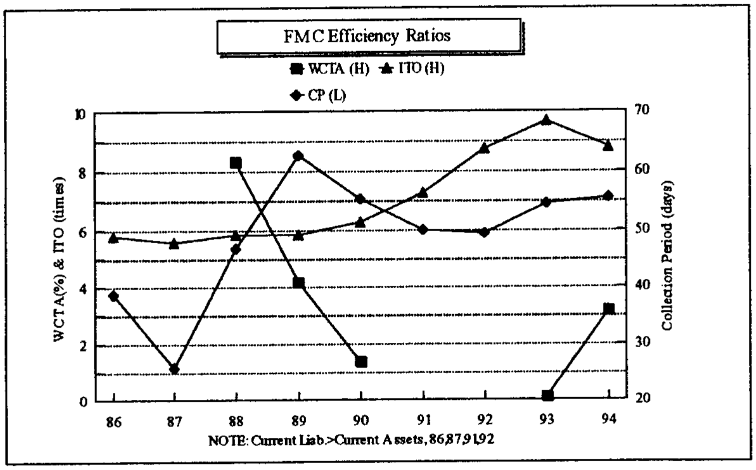

Figure 3-8. FMC Efficiency Ratios ('86-'94).

c. Profitability

Figure 3-9 displays FMC's profitability ratios for the period of study. While ROI is somewhat meaningless due to equity deficit, ROA shows a downward trend, thus indicating decreasing profitability. The GMR remains steady over the period of study, indicating steady profitability.

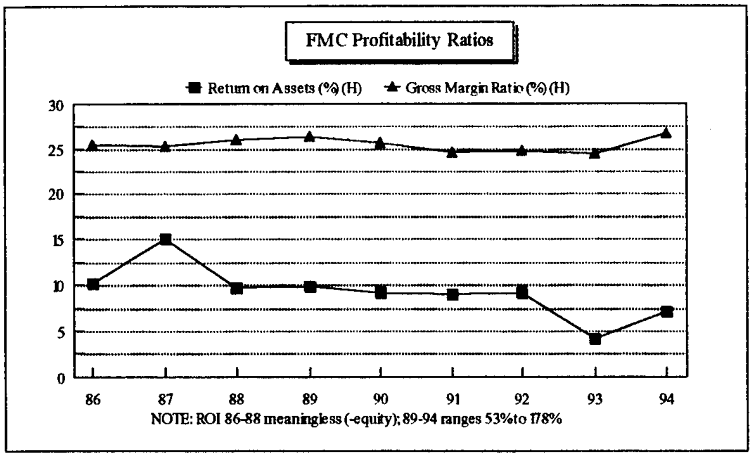

Figure 3-9. FMC Profitability Ratios ('86-'94).

4. General Electric Company

a. Solvency

Figure 3-10 displays GE's solvency ratios for the period of study. In terms of its upward trend and its magnitude, the DE ratio indicates decreased solvency. Although the firm's CR shows a slightly upward trend, its value remains less than 2.

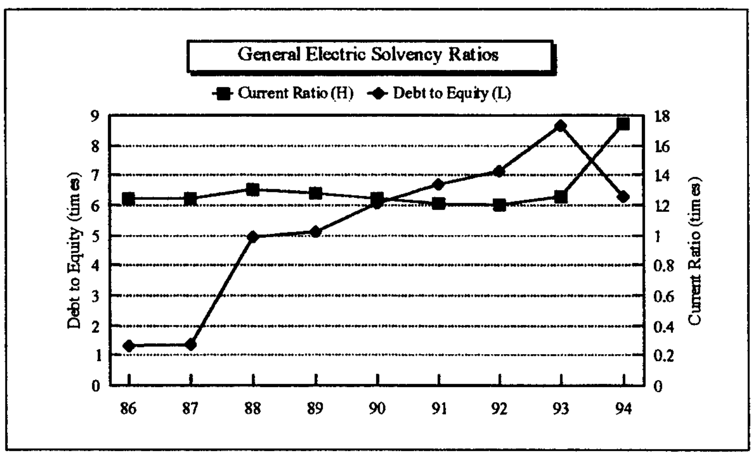

Figure 3-10. General Electric Solvency Ratios ('86-'94).

b. Efficiency

Figure 3-11 displays GE's efficiency ratios for the period of study. The graph shows a mixed picture of the firm's efficiency. The upward WCTA and ITO trends indicate growing efficiency, while the upward CP trend tends to counter such a finding.

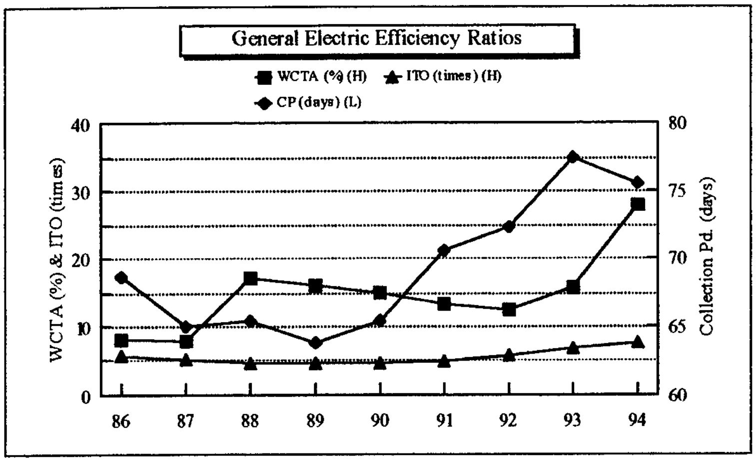

Figure 3-11. General Electric Efficiency Ratios ('86-'94).

c. Profitability

Figure 3-12 displays GE's profitability ratios for the period of study. Again, the graph shows a mixed view. The increasing ROI, and steady GMR indicate increased profitability. However, this finding is somewhat offset by the downward ROA trend.

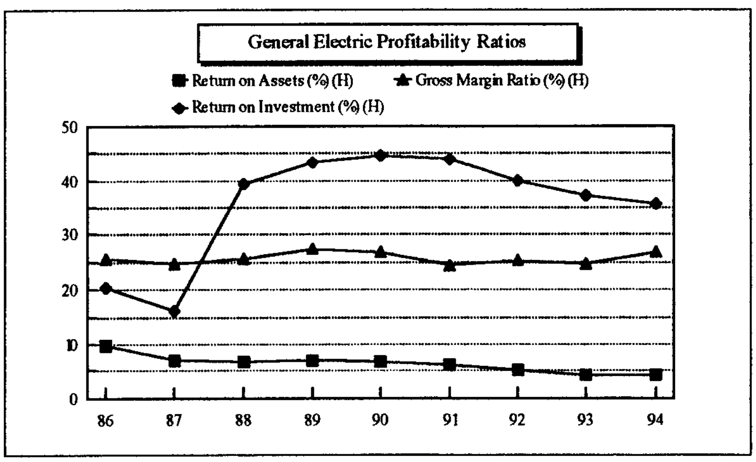

Figure 3-12. General Electric Profitability Ratios ('86-'94).

5. General Dynamics Corporation

a. Solvency

Figure 3-13 displays GD's solvency ratios for the period of study. Despite the spike in '90 (caused by reduced equity), the graph shows the firm to be quite solvent. The firm's upward CR trend and downward DE trend both indicate favorable solvency.

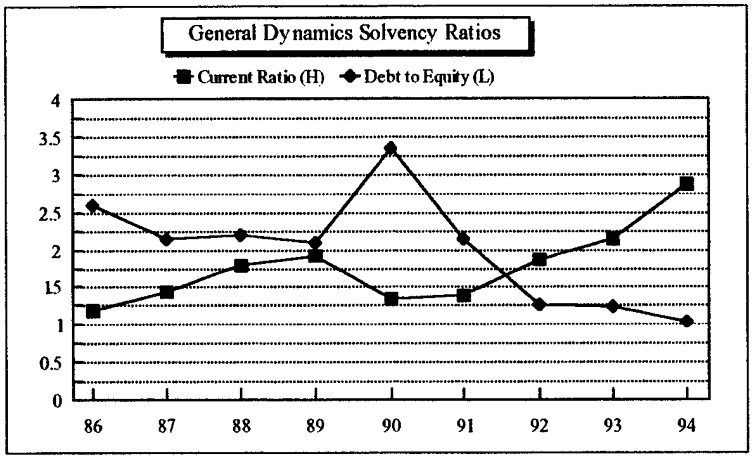

Figure 3-13. General Dynamics Solvency Ratios ('86-'94).

b. Efficiency

Figure 3-14 displays GD's efficiency ratios for the period of study. The trends of all three ratios reflect increasingly efficient operations. The upward WCTA trend indicates growing working capital. The downward CP trend indicates more rapid collection of receivables. And the upward ITO trend indicates more rapid inventory turn.

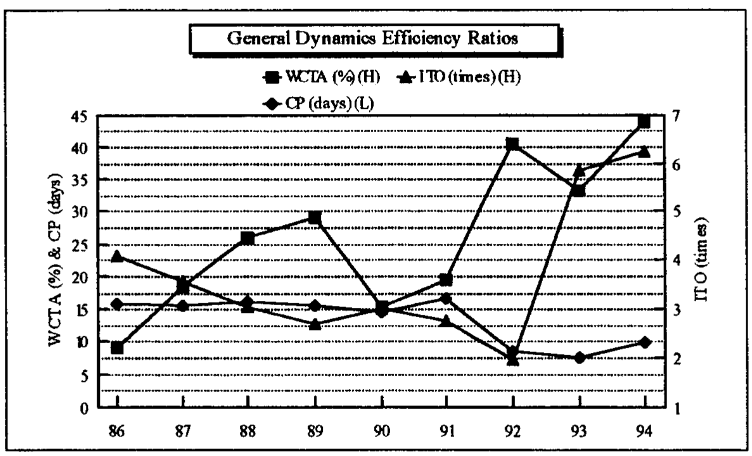

Figure 3-14. General Dynamics Efficiency Ratios ('86-'94).

c. Profitability

Figure 3-15 displays GD's profitability ratios for the period of study. Except for '86 and '90, when the firm lost money, the firm's profitability remains fairly stable. As indicated by the sharp reduction in GMR in '90, the company was unprofitable that year (despite increased sales revenue) due to increased expenses.

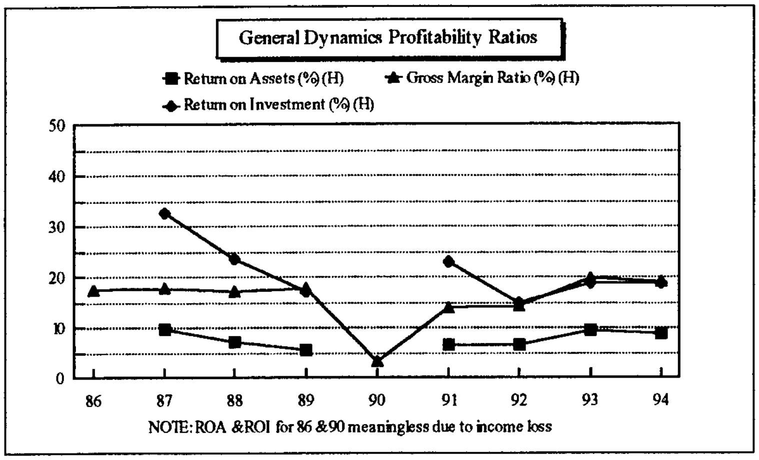

Figure 3-15. General Dynamics Profitability Ratios ('86-'94).

6. General Motors Corporation

a. Solvency

Figure 3-16 displays GM's solvency ratios for the period of study. The graph shows trends indicating relative insolvency. The firm's DE ratios increase steadily from '86-'91, and then increase drastically over the next two years, and remain at a value whereby liabilities were nearly 15 times greater than equity in '94. The slight downward CR trend and magnitudes also indicate poor performance in terms of solvency.

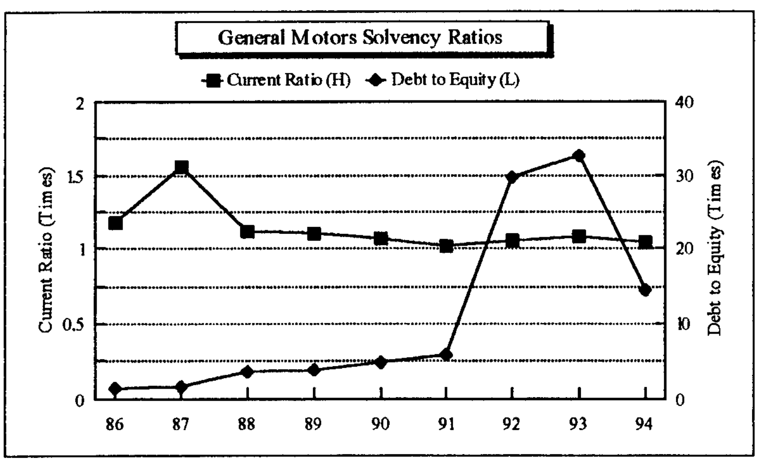

Figure 3-16. General Motors Solvency Ratios ('86-'94).

b. Efficiency

Figure 3-17 displays GM's efficiency ratios for the period of study. The graph shows a somewhat mixed picture of the firm's efficiency. The downward CP trend

indicates faster collection of receivables, but the downward WCTA trend indicates decreasing amounts of working capital available to finance ongoing operations. The ITO remains steady over the period of study.

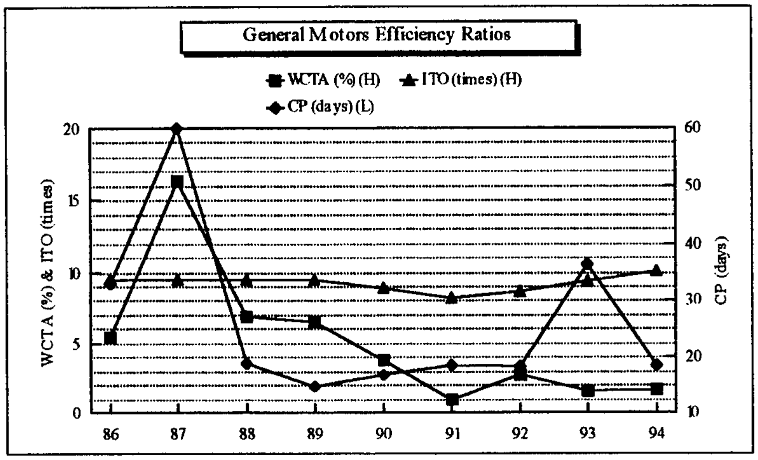

Figure 3-17. General Motors Efficiency Ratios ('86-'94).

c. *Profitability*

Figure 3-18 displays GM's profitability ratios for the period of study. The indicators of the firm's profitability are also somewhat mixed. The company lost money from '90-'92, but the GMR trend is upward, thus reflecting increasing profitability.

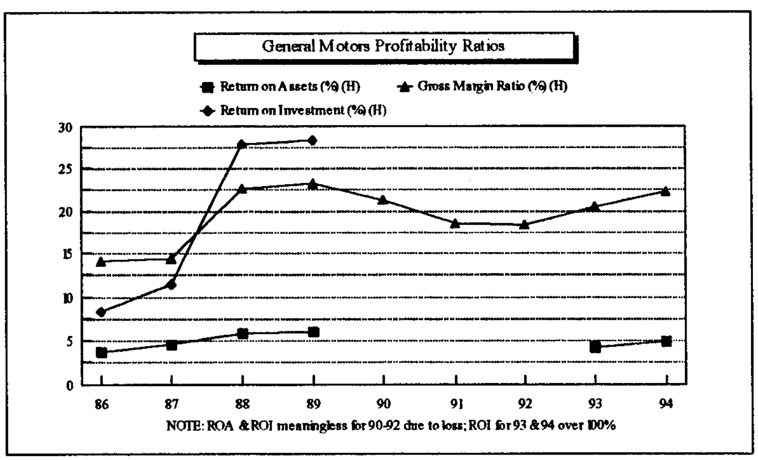

Figure 3-18. General Motors Profitability Ratios ('86-'94).

7. Grumman Corporation

a. Solvency

Figure 3-19 displays Grumman's solvency ratios for the period of study. The graph shows a somewhat mixed review of the firm's solvency. Despite dropping below 2 in '94, the CR indicates solid solvency. Despite climbing over 3.5 in '94, the DE ratio indicates relative stability in the amounts of debt and equity.

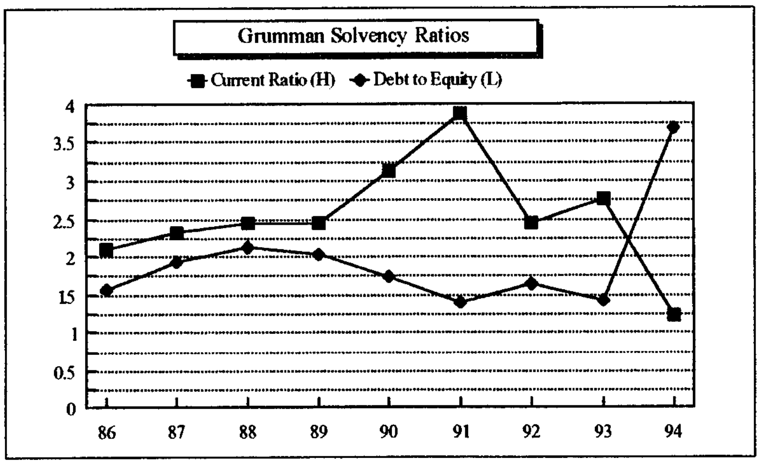

Figure 3-19, Grumman Solvency Ratios ('86-'94).

b. Efficiency

Figure 3-20 displays Grumman's efficiency ratios for the period of study. As indicated by the graph, the firm's efficiency is somewhat unclear. Despite an upward trend during the first half of the study, the CP declines steadily over the last half of the period, thus indicating increasingly efficient operations. Likewise, except for '94, when the WCTA ratio dropped drastically, the trend is upward, indicating increased efficiency. Regarding ITO, the graph indicates inefficiency in that there is a downward trend during the first half of the study. However, the ITO values during the latter half of the time period indicate more efficient operations, as the ITO trend climbs steadily.

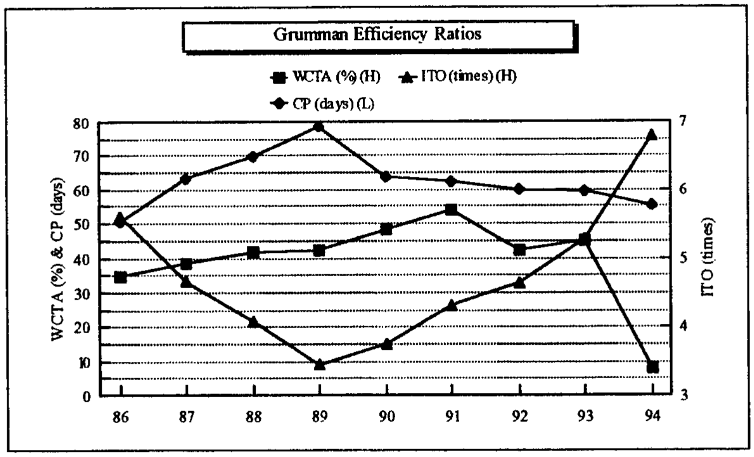

Figure 3-20. Grumman Efficiency Ratios ('86-'94).

c. Profitability

Figure 3-21 displays Grumman's profitability ratios for the period of study. Until '92, when the company lost money, the trends for ROI and ROA are upward, indicating increased profitability. Although profits are achieved for '93 and '94, returns decreased. The GMR trend is upward, indicating increased profitability.

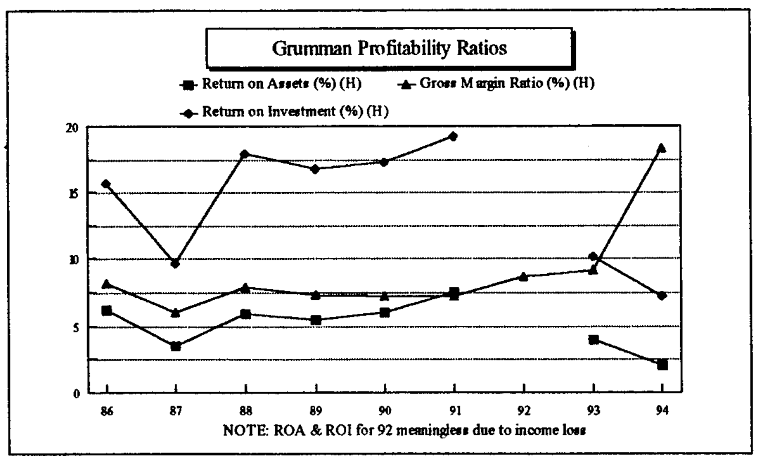

Figure 3-21, Grumman Profitability Ratios ('86-'94).

8. GTE Corporation

a. Solvency

Figure 3-22 displays GTE's solvency ratios for the period of study. As indicated by the upward DE trend and the downward CR trend, the graph shows decreasing solvency for the firm.

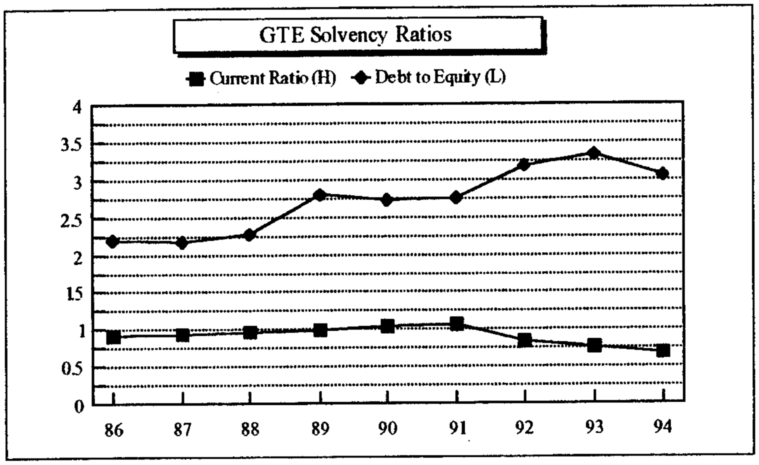

Figure 3-22. GTE Solvency Ratios ('86-'94).

b. Efficiency

Figure 3-23 displays GTE's efficiency ratios for the period of study. The firm's efficiency ratios are somewhat mixed. Negative working capital indicates extremely inefficient operations, a view reinforced by an upward CP trend. However, this evaluation is tempered by the upward ITO trend.

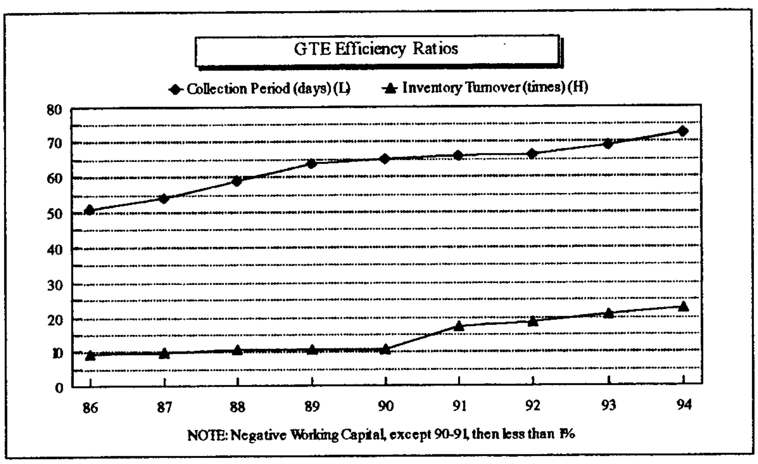

Figure 3-23. GTE Efficiency Ratios ('86-'94).

c. Profitability

Figure 3-24 displays GTE's profitability for the period of study. Although there are fluctuations, the graph shows the firm's profitability to be steady to increasing. The upward GMR and ROI trends indicate increased profitability. ROA remains relatively stable.

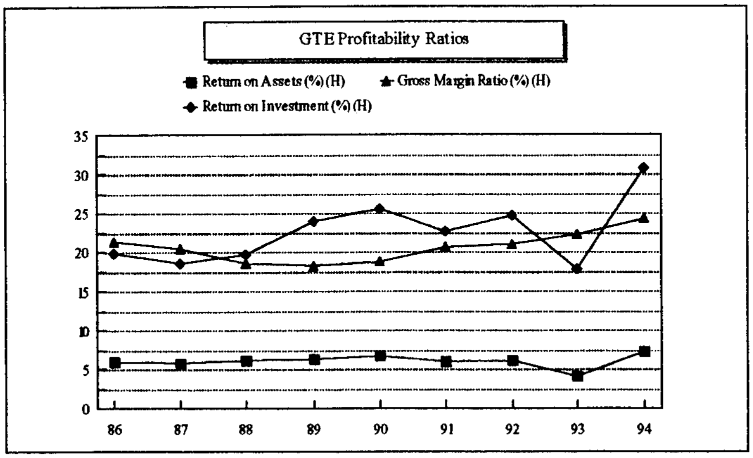

Figure 3-24. GTE Profitability Ratios ('86-'94).

9. Harris Corporation

a. Solvency

Figure 3-25 displays Harris' solvency ratios for the period of study. Except for '89, the firm's solvency improves from year-to-year. Excluding '89, the firm's upward CR trend and downward DE trend indicate increased solvency. The '89 conditions are probably brought about because of two key acquisitions that year.

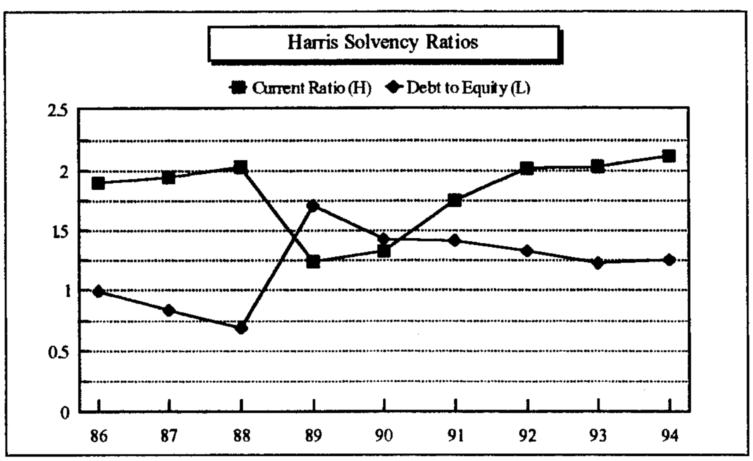

Figure 3-25. Harris Solvency Ratios ('86-'94).

b. Efficiency

Figure 3-26 displays Harris' efficiency ratios for the period of study. The impact of the '89 purchases is also shown by the sharp decline in the firm's working capital during that year. Excluding this year, the firm's WCTA trend is increasing. Also

indicative of efficient operations, the ITO trend is similarly upward. The CP trend remains relatively unchanged.

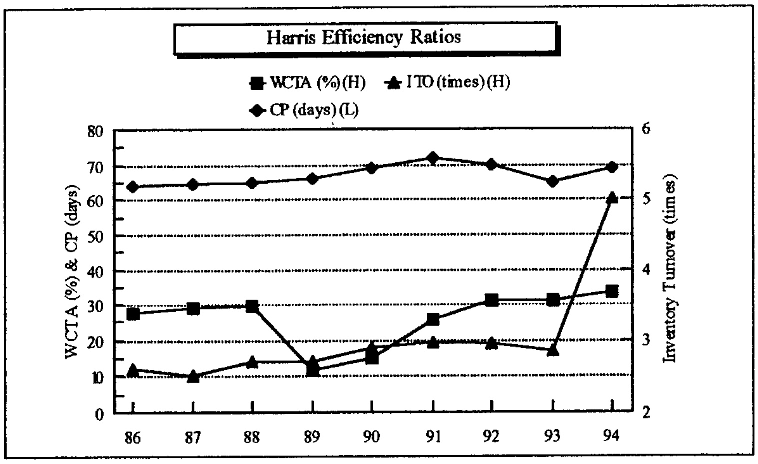

Figure 3-26. Harris Efficiency Ratios ('86-'94).

c. *Profitability*

Figure 3-27 displays Harris' profitability ratios for the period of study. Despite fluctuations between '89 and '91, the firm's profits remain relatively steady. Lower returns in '89 can also be attributed to the aforementioned acquisitions.

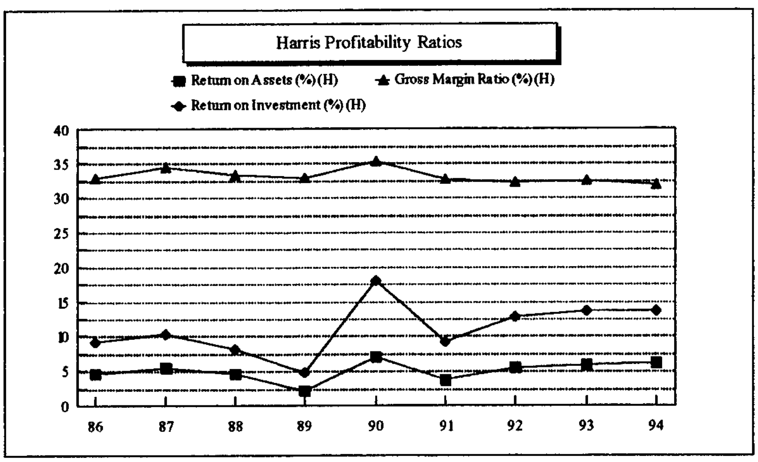

Figure 3-27. Harris Profitability Ratios ('86-'94).

10. Honeywell Incorporated

a. Solvency

Figure 3-28 displays Honeywell's solvency ratios for the period of study. The graph shows the firm's solvency is well established. The downward DE trend and magnitudes, and the upward CR trend and magnitudes, reinforce this view.

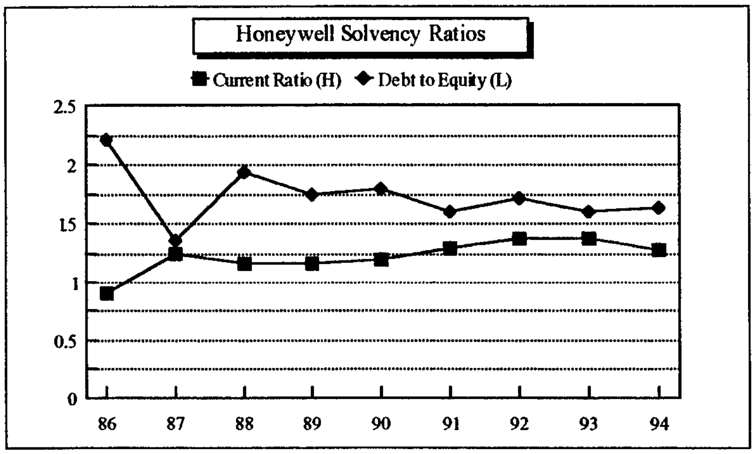

Figure 3-28. Honeywell Solvency Ratios ('86-'94).

b. Efficiency

Figure 3-29 displays Honeywell's efficiency ratios for the period of study. The graph shows a mixed interpretation of the firm's efficiency. Despite negative working capital in '86, the firm experiences an upward WCTA trend, indicating efficient operations. This view is supported by the increasing ITO trend. However, indicative of relatively inefficient operations, the firm experiences growing collection periods.

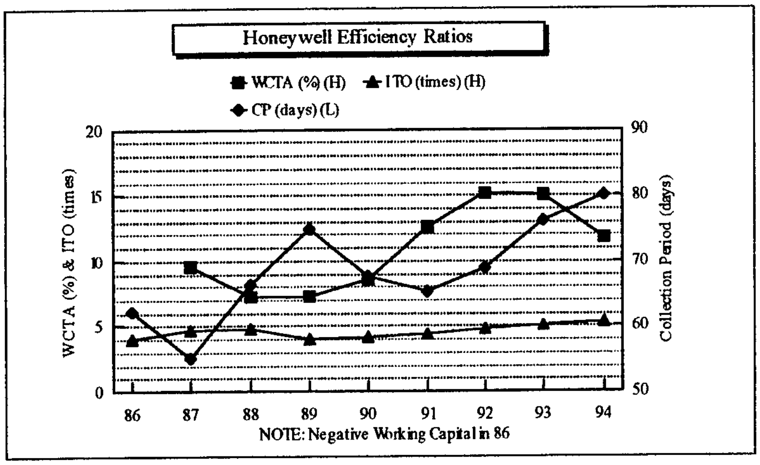

Figure 3-29. Honeywell Efficiency Ratios ('86-'94).

c. *Profitability*

Figure 3-30 displays Honeywell's profitability ratios for the period of study. The graph indicates the firm's profitability has declined somewhat. This is indicated by the low returns in '86, no returns in '88 (when the company lost money), and steadily declining returns thereafter. However, except for '88, the GMR shows slight increases in value.

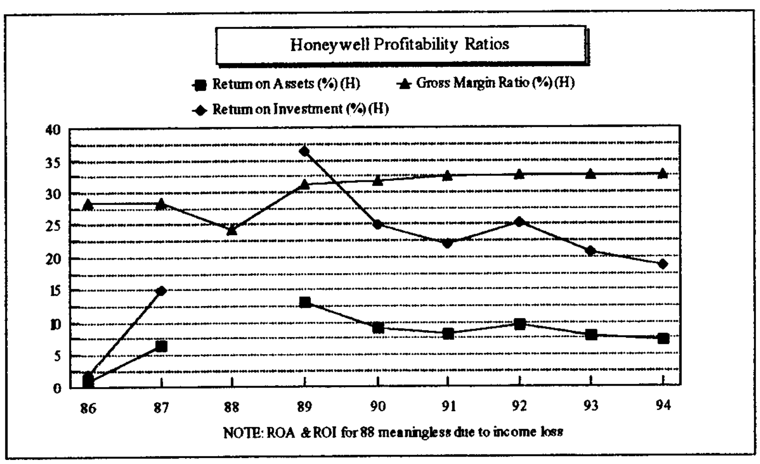

Figure 3-30. Honeywell Profitability Ratios ('86-'94).

11. International Business Machines (IBM) Corporation

a. *Solvency*

Figure 3-31 displays IBM's solvency ratios for the period of study. While the trends (DE rising and CR dropping) are moving toward a generally less solvent position, the magnitudes of these ratios are indicative of a relatively solvent firm.

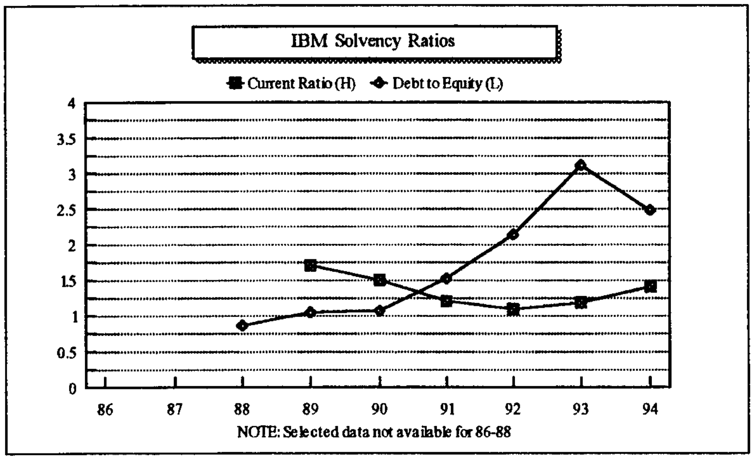

Figure 3-31. IBM Solvency Ratios ('86-'94).

b. Efficiency

Figure 3-32 displays IBM's efficiency ratios for the period of study. Although much of the efficiency ratio data are unavailable, the graph reflects a somewhat mixed picture of the efficiency of the firm's operations. Until '92, the WCTA trend drops steadily, thus reflecting inefficient operations. However, the upward trend thereafter indicates efficient operations. The trends for the other efficiency ratios (downward CP and upward ITO) reflect more efficient operations.

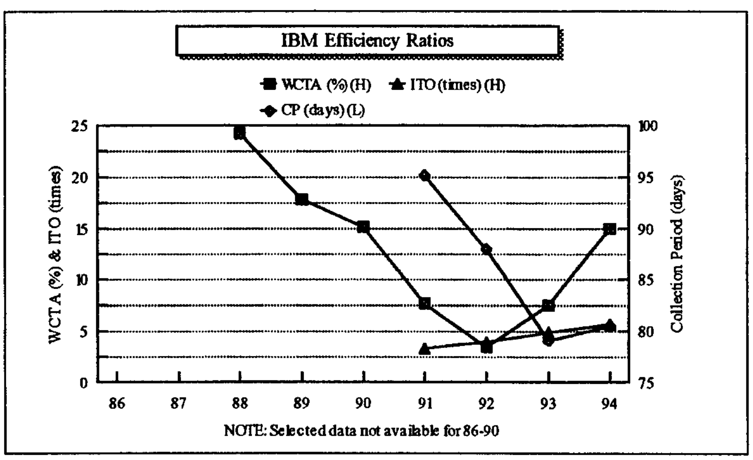

Figure 3-32. IBM Efficiency Ratios ('86-'94).

c. Profitability

Figure 3-33 displays IBM's profitability ratios for the period of study. Although much of the data are unavailable, the graph indicates that profits over the first

half of the study period are stable. However, the downward GMR trend and loss of income from '91-'93 reflect a lower profitability position over the latter half of the study.

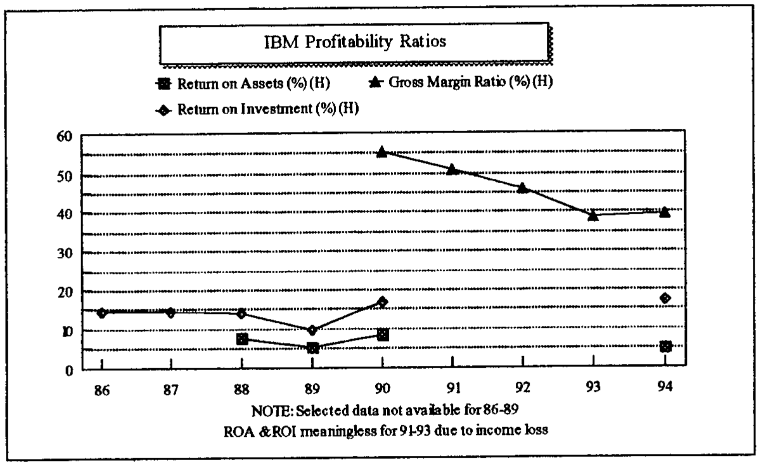

Figure 3-33. IBM Profitability, ('86-'94).

12. ITT Corporation

a. Solvency

Figure 3-34 displays ITT's solvency ratios for the period of study. The graph shows a trend toward extreme insolvency for the firm. The DE trend moves drastically upward, while the CR plummets.

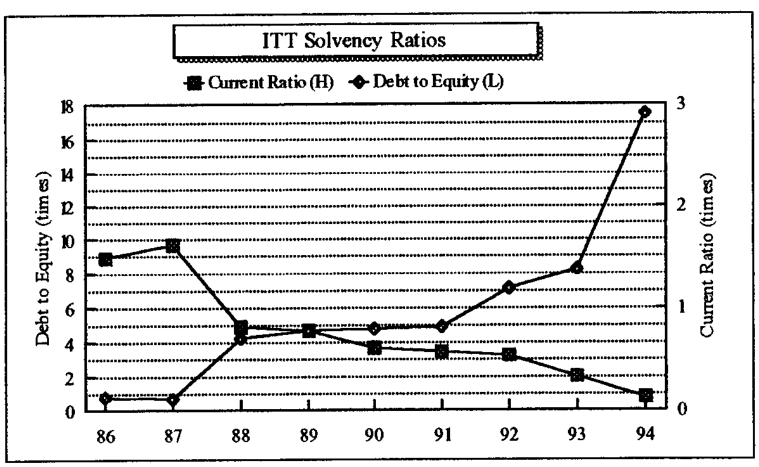

Figure 3-34. ITT Solvency Ratios ('86-'94).

b. Efficiency

Figure 3-35 displays ITT's efficiency ratios for the period of study. Indicative of extreme inefficiency, the firm experienced negative working capital for most of the period. Additionally, the increasing CP trend indicates growing inefficiency. However, this view is tempered by an increasing ITO trend.

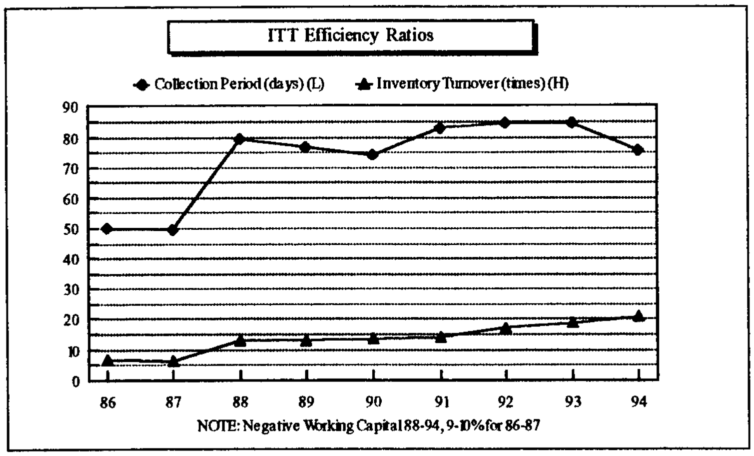

Figure 3-35. ITT Efficiency Ratios ('86-'94).

c. Profitability

Figure 3-36 displays ITT's profitability ratios for the period of study. For every measure, the profitability trend is downward, showing decreasing profitability. Profitability in '92 was particularly poor as the firm not only lost money, but its expenses exceeded its sales revenues. Although '87 appears to have been exceptionally profitable, the ratios steadily declined afterward.

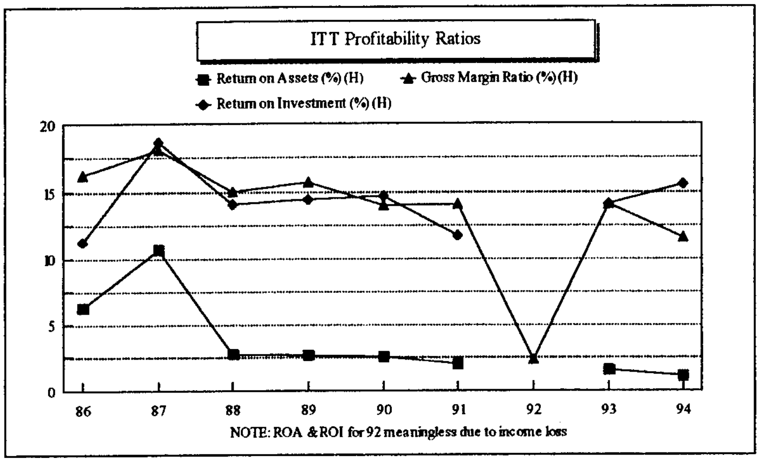

Figure 3-36. ITT Profitability Ratios ('86-'94).

13. Litton Industries Incorporated

a. Solvency

Figure 3-37 displays Litton's solvency ratios for the period of study. The graph shows the firm to be moderately solvent in that DE is declining and the CR values remain above one. However, the CR trend declines over the last half of the period, and the DE rises significantly in '94.

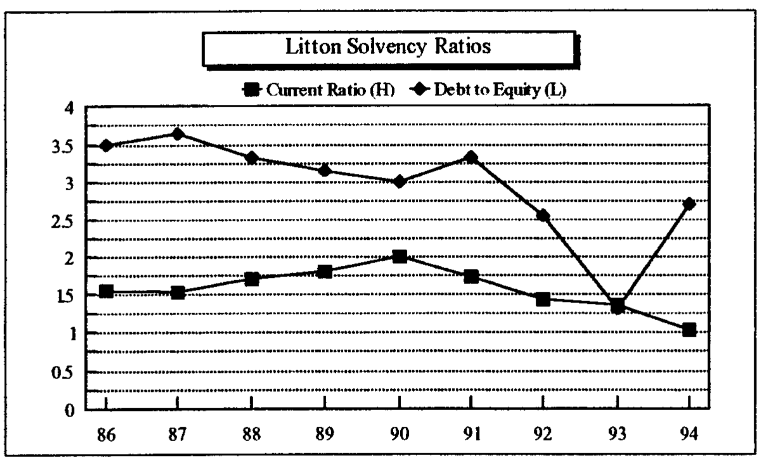

Figure 3-37. Litton Solvency Ratios ('86-'94).

b. Efficiency

Figure 3-38 displays Litton's efficiency ratios for the period of study. As indicated by the graph, the firm's efficiency is somewhat unclear. Despite an upward trend during the first half of the study, the CP declines steadily over the last half of the period,

thus indicating increasingly efficient operations. However, the WCTA curve is identical to the CP curve, thus countering it by showing opposite efficiency trends. Regarding ITO, the graph indicates inefficiency in that there is a downward trend during the first half of the study. However, the ITO values during the latter half of the time period indicate more efficient operations, as the ITO trend climbs steadily.

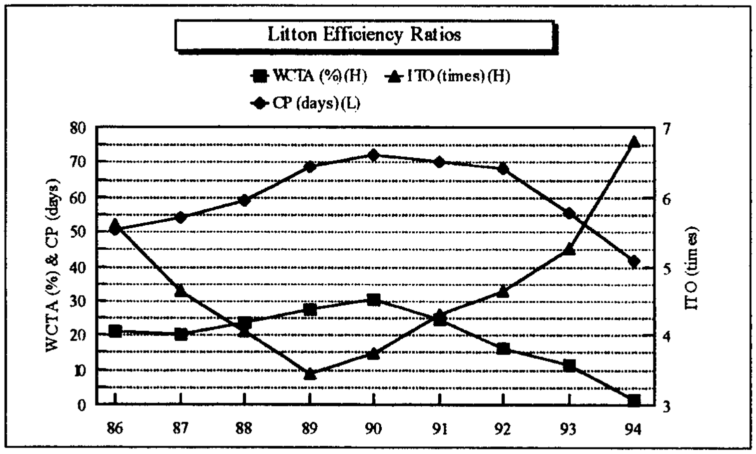

Figure 3-38. Litton Efficiency Ratios ('86-'94).

c. Profitability

Figure 3-39 displays Litton's profitability ratios for the period of study. The graph shows profitability ratios that indicate increasing profitability during the first five years of study, followed by declining profits over the remainder of the period. Returns drop significantly in '91, although GMR continues to climb through '92.

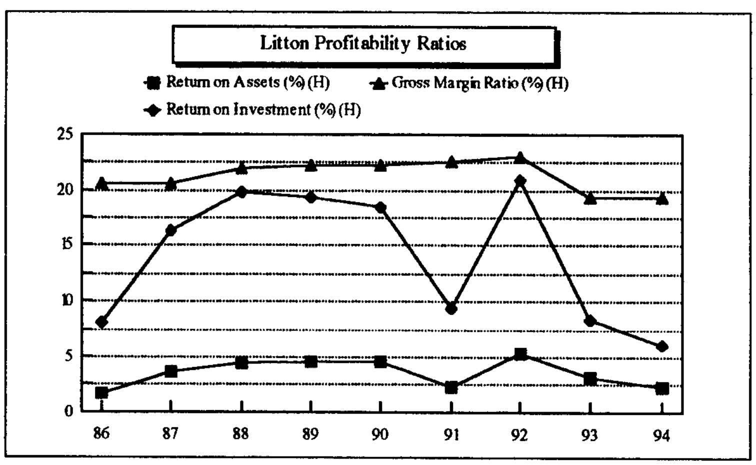

Figure 3-39. Litton Profitability Ratios ('86-'94).

14. Lockheed Corporation

a. Solvency

Figure 3-40 displays Lockheed's solvency ratios for the period of study. Although the CR values are under 2 and the DE values are over 1, the ratio trends and magnitudes indicate relative solvency.

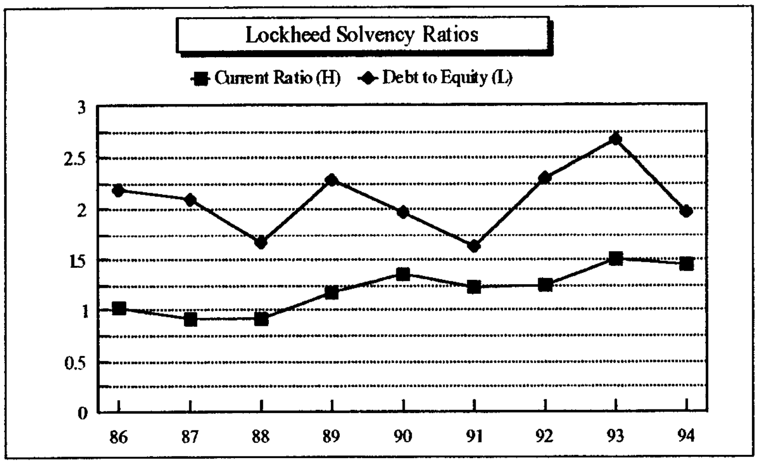

Figure 3-40. Lockheed Solvency Ratios ('86-'94).

b. Efficiency

Figure 3-41 displays Lockheed's efficiency ratios for the period of study. The graph shows a mixed view of the firm's efficiency over time. Until '90 the CP is increasing, thereby indicating decreasingly efficient operations. However, the CP trend over the latter half of the study indicates more efficient operations. Low WCTA in '86 and negative working capital in '87-'88 reveal inefficiency. However, this situation is improved during the remainder of the period, as the WCTA trend moves upward. The ITO trend moves steadily downward, indicative of inefficient operations.

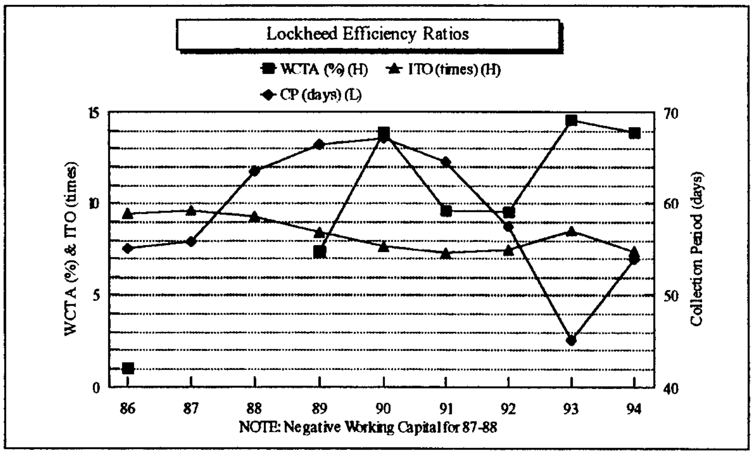

Figure 3-41. Lockheed Efficiency Ratios ('86-'94).

c. Profitability

Figure 3-42 displays Lockheed's profitability ratios for the period of study. Except for '89, the firm's GMR and ROA are relatively stable. However, the downward ROI trend indicates decreasing profitability. The drastic reduction in profits in '89 are due, in part, to restructuring costs and write-offs on fixed-price contracts.

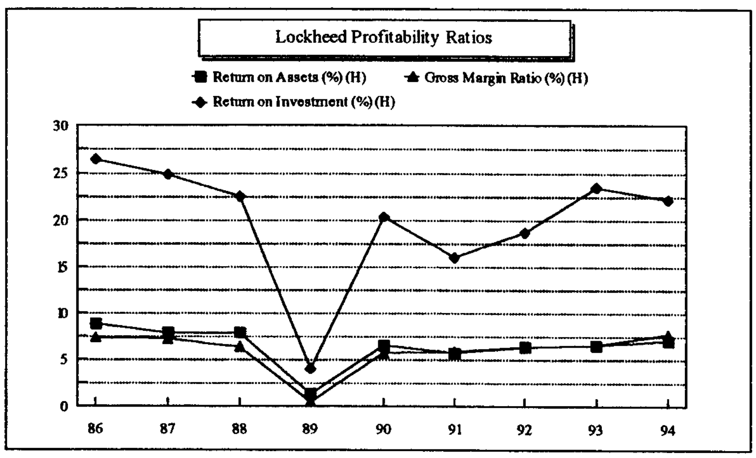

Figure 3-42. Lockheed Profitability Ratios ('86-'94).

15. Loral Corporation

a. Solvency

Figure 3-43 displays Loral's solvency ratios for the period of study. Although there is some fluctuation over the years, the graph shows the firm to be quite solvent. This view is reinforced by the downward CP trend shown in figure 3-44.

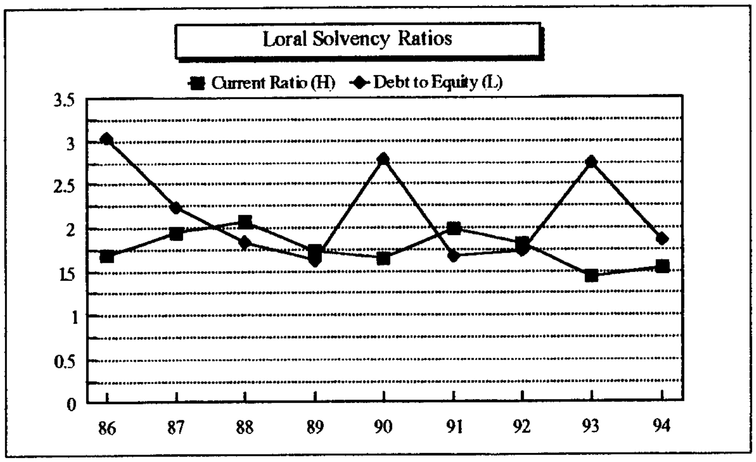

Figure 3-43. Loral Solvency Ratios ('86-'94).

b. Efficiency

Figure 3-44 displays Loral's efficiency ratios for the period of study. Like so many other sample firms, the firm's efficiency picture is unclear. As mentioned above, the downward CP trend is a positive sign of both solvency and efficiency. However, the declining WCTA trend indicates less efficient operations. Finally, the upward ITO trend indicates increasingly efficient operations.

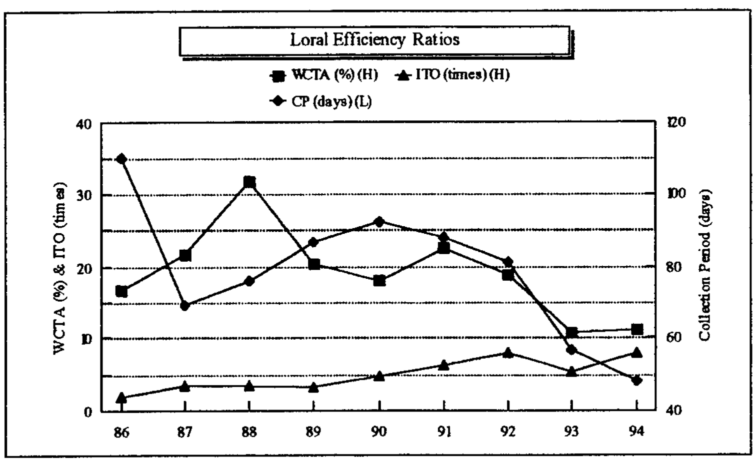

Figure 3-44. Loral Efficiency Ratios ('86-'94).

c. Profitability

Figure 3-45 displays Loral's profitability ratios for the period of study. While ROA remains relatively steady, ROI and GMR seem to mirror each other. This

reciprocal relationship is shown by the declining trend in GMR, while the ROI trend is upward, indicating increasing profitability.

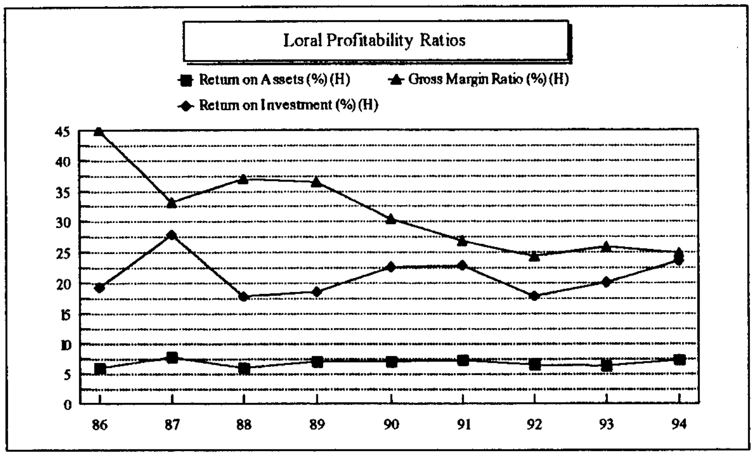

Figure 3-45. Loral Profitability Ratios ('86-'94).

16. The LTV Corporation

a. Solvency

Figure 3-46 displays LTV's solvency ratios for the period of study. The firm emerged from bankruptcy protection in '93, and therefore was highly insolvent until then. Between '93 and '94, the company further reduced its debt, as shown by the reduced DE ratio. Although CR declines sharply in '93 (perhaps to pay off debt), its stable value of around 3 indicates relative solvency despite the firm's bankruptcy.

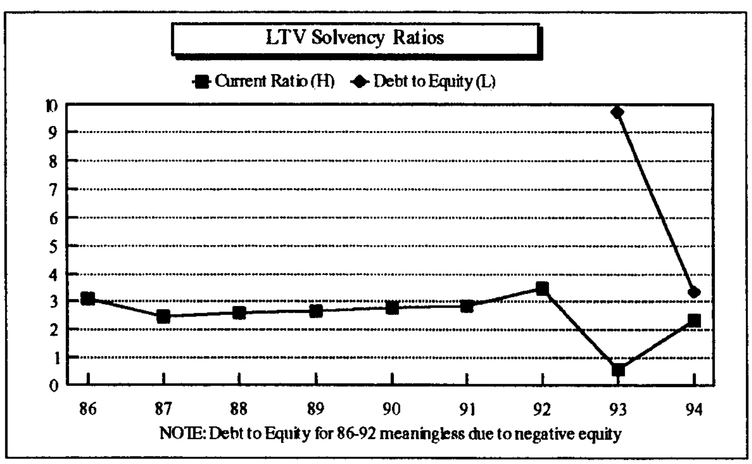

Figure 3-46. LTV Solvency Ratios ('86-'94).

b. Efficiency

Figure 3-47 displays LTV's efficiency ratios for the period of study. The graph indicates the effects of the firm's emergence from bankruptcy in '93 in that it experiences negative working capital, longer CP, and lower ITO -- all signs of inefficient operations. Prior to '93, the firm's WCTA and CP remains relatively unchanged, while the ITO trend moves downward, thus reflecting less efficient operations.

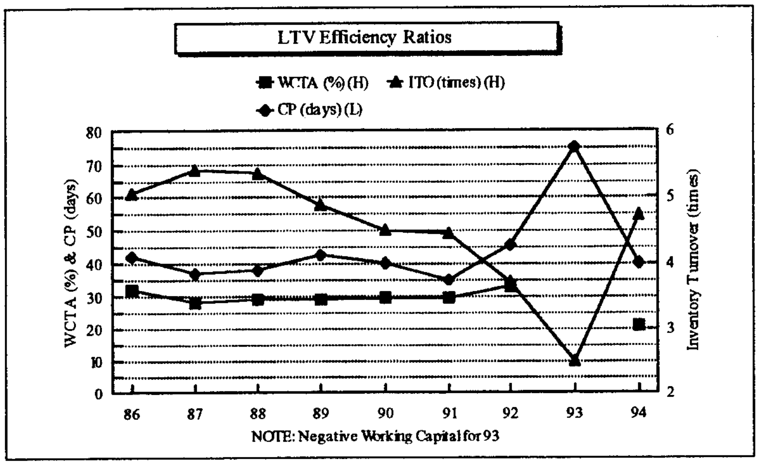

Figure 3-47. LTV Efficiency Ratios ('86-'94).

c. Profitability

Figure 3-48 displays LTV's profitability ratios for the period of study. Because of the firm's bankruptcy, ROI and ROA are either meaningless or unreliable indicators of profitability. Through '92, the trend for the GMR is downward, indicating decreasing profitability. This situation improved somewhat via the sale of three of its divisions in '92-'93.

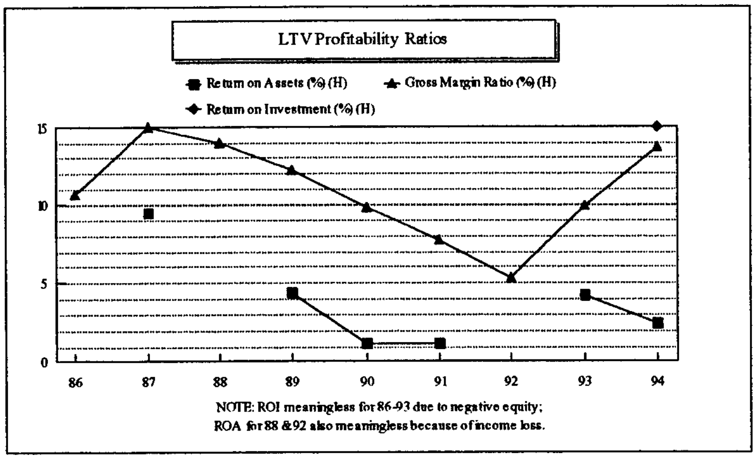

Figure 3-48. LTV Profitability Ratios ('86-'94).

17. Martin Marietta Corporation

a. Solvency

Figure 3-49 displays Martin Marietta's solvency ratios for the period of study. The graph indicates changing solvency trends over time. Through '92 the firm's CR and DE trends both move in more solvent directions. Although the magnitudes are not severe, these trends reverse themselves after '92.

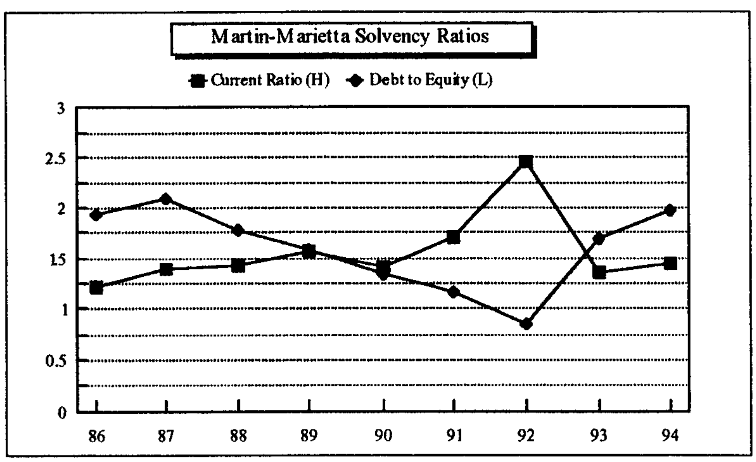

Figure 3-49. Martin Marietta Solvency Ratios ('86-'94).

b. Efficiency

Figure 3-50 displays Martin Marietta's efficiency ratios for the period of study. The graph shows a mixed interpretation of the firm's efficiency over time. Through

'92, the WCTA trend rises upward, only to fall afterward. Similarly, the ITO trend remains steady through '92 then climbs and falls during the last two years of study. A sign of less efficient operations, the trend for CP increases upward.

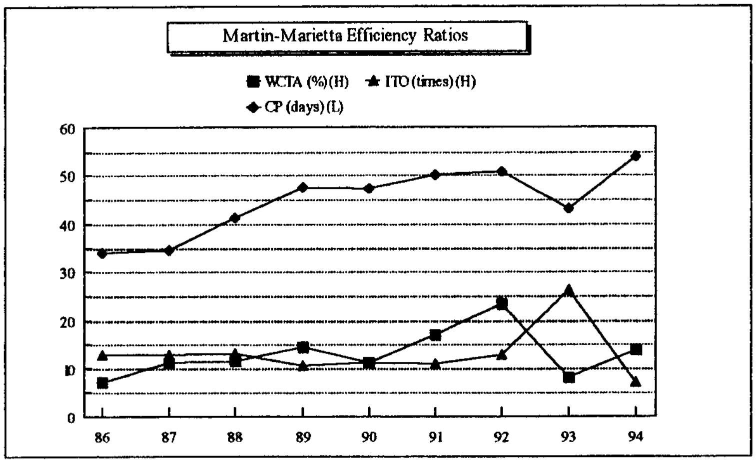

Figure 3-50. Martin Marietta Efficiency Ratios ('86-'94).

*c. **Profitability***

Figure 3-51 displays Martin Marietta's profitability ratios for the period of study. Although, prior to '93, the firm's ROA and GMR remain relatively stable, and its ROI steadily decreases, in '93 the returns drop drastically. This profitability drop is temporary, and probably the result of the acquisition of GE Aerospace and the pending purchase of a division of GD.

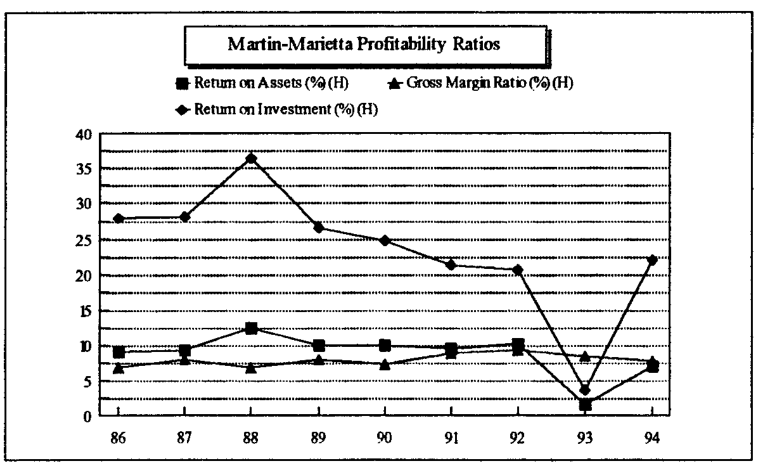

Figure 3-51. Martin Marietta Profitability Ratios ('86-'94).

18. McDonnell Douglas Corporation

a. Solvency

Figure 3-52 displays MDC's solvency ratios for the period of study. Although the firm has been relatively solvent, the graph indicates that its solvency has changed over time. Although it declines over the latter part of the study, the DE trend moves upward. The CR trend, on the other hand, remains relatively stable after '88. Another indicator of more solvent operations, is the decreasing CP in Figure 3-53.

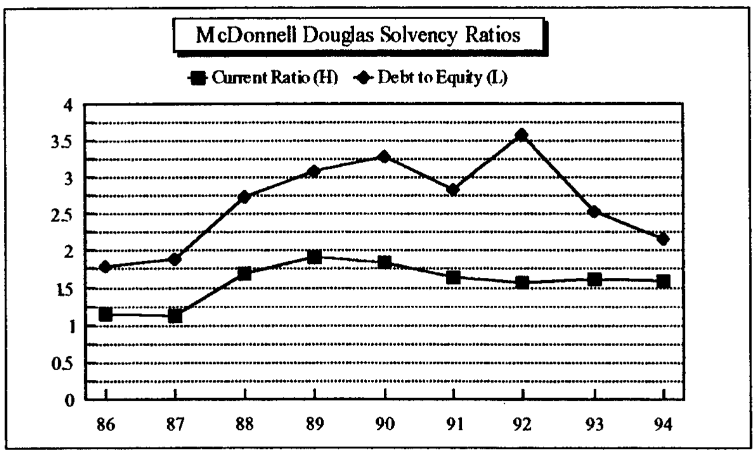

Figure 3-52. McDonnell Douglas Solvency Ratios ('86-'94).

b. Efficiency

Figure 3-53 displays MDC's efficiency ratios for the period of study. The firm's efficiency ratios give a mixed interpretation of its efficiency. The downward CP trend indicates efficiency, while the downward ITO trend indicates relative inefficiency. Although the WCTA trend is upward from '86-89, since then it declines steadily, thus giving a somewhat unclear indicator of the firm's operating efficiency.

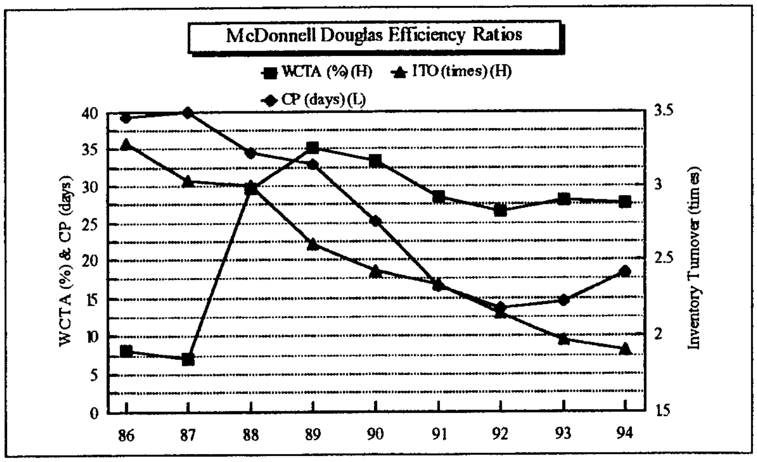

Figure 3-53. McDonnell Douglas Efficiency Ratios ('86-'94).

c. Profitability

Figure 3-54 displays MDC's profitability ratios for the period of study. The graph also shows a confusing profitability picture. Except in '89, when the company lost money, the ROA remains relatively unchanged, while the GMR trend moves slightly downward, and the ROI trend moves upward.

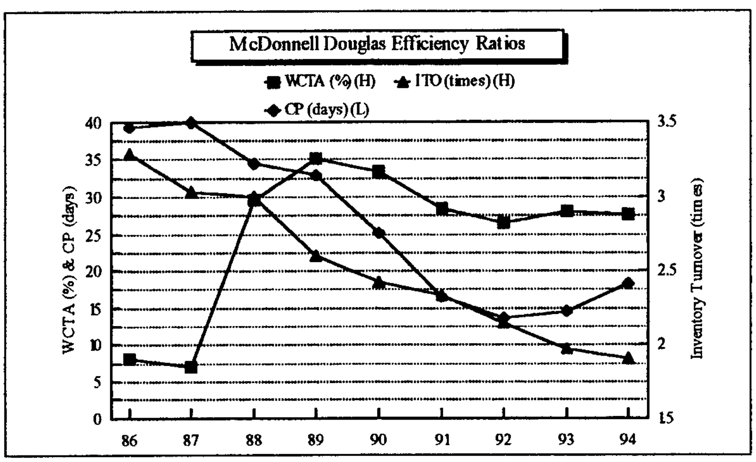

Figure 3-54. McDonnell Douglas Profitability Ratios ('86-'94).

19. Motorola Incorporated

a. Solvency

Figure 3-55 displays Motorola's solvency ratios for the period of study. The graph shows a firm which is extremely solvent. This is clear from the relatively stable

trends in CR, DE and CP ratios. Most noteworthy is the magnitude of the firm's DE ratios (approximately 1:1 debt to equity).

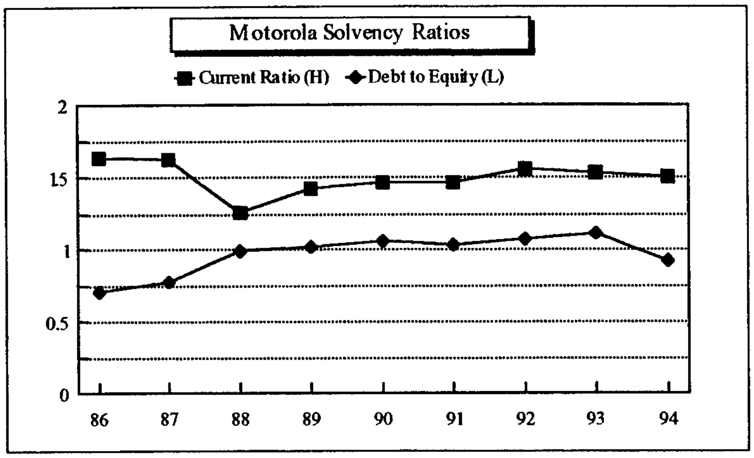

Figure 3-55. Motorola Solvency Ratios ('86-'94).

b. Efficiency

Figure 3-56 displays Motorola's efficiency ratios for the period of study. Although WCTA and CP remain relatively unchanged, the upward ITO trend indicates increasingly efficient operations by the firm.

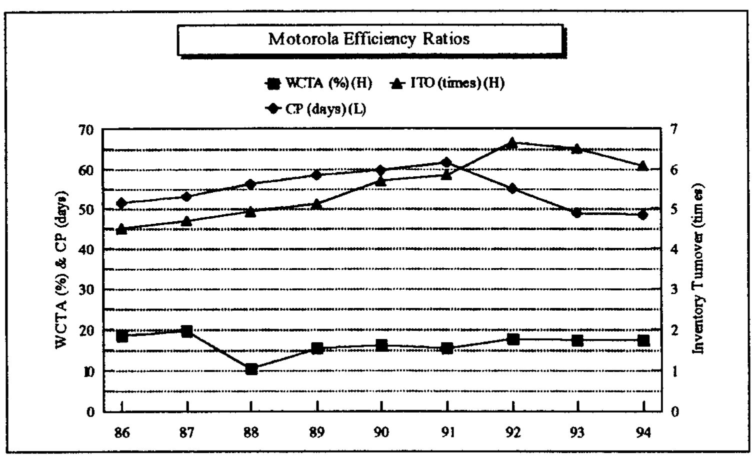

Figure 3-56. Motorola Efficiency Ratios ('86-'94).

c. Profitability

Figure 3-57 displays Motorola's profitability ratios for the period of study. The firm appears to have been quite profitable. This is indicated by the steady GMR, and the increasing ROA and ROI values over the period of study.

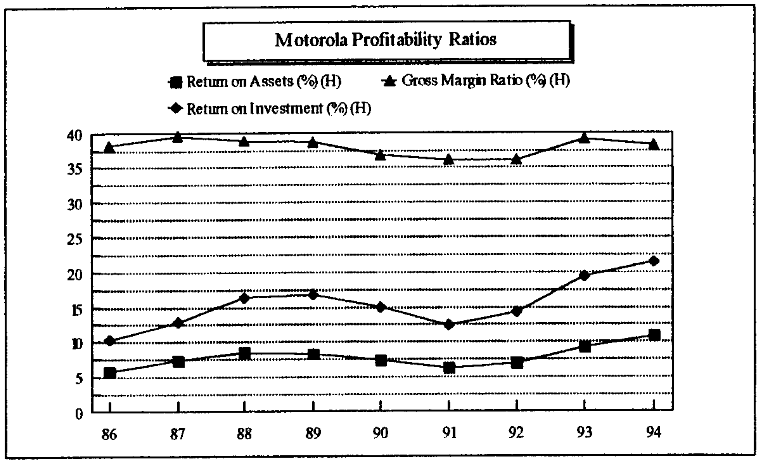

Figure 3-57. Motorola Profitability Ratios ('86-'94).

20. Northrop Corporation

a. Solvency

Figure 3-58 displays Northrop's solvency ratios for the period of study. Although the DE ratio shoots up in '94, the downward prior trend provides a positive indicator of the firm's solvency, as does the upward CR trend.

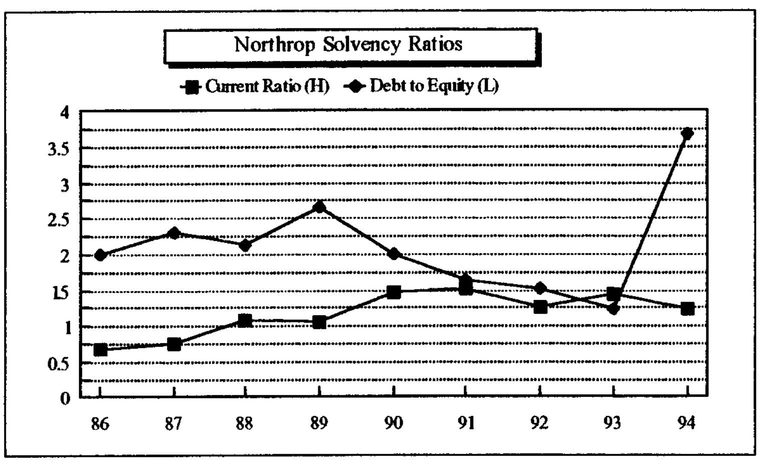

Figure 3-58. Northrop Solvency Ratios ('86-'94).

b. Efficiency

Figure 3-59 displays Northrop's efficiency ratios for the period of study. The graph shows a somewhat confusing picture of the firm's efficiency. Although the negative working capital in '86-'87 is a sign of inefficiency, the WCTA trend increases despite some fluctuation. The CP curve also shows this fluctuation, but since '89 the trend

is toward more efficient collection of receivables. An indicator of decreasingly efficient operations is the downward ITO trend.

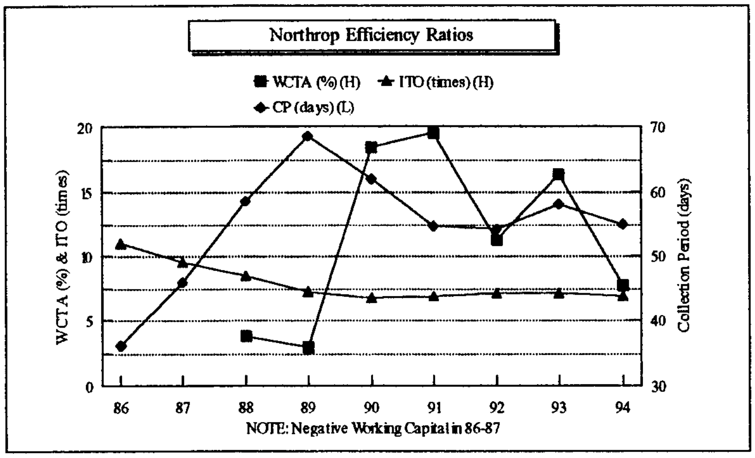

Figure 3-59. Northrop Efficiency Ratios ('86-'94).

c. *Profitability*

Figure 3-60 displays Northrop's profitability ratios for the period of study. The graph shows an unclear view the firm's profitability. Despite losing money in '88-'89, the firm's GMR trend moves upward to indicate a more profitable position. However, since the loss, the ROI and ROA trends both indicate declining profits.

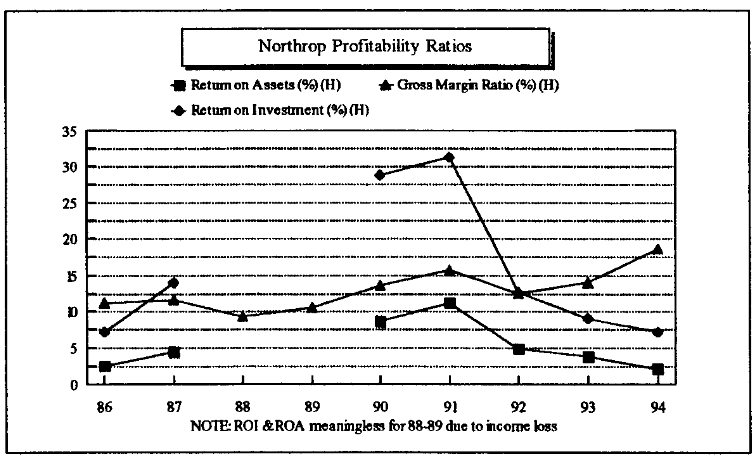

Figure 3-60. Northrop Profitability Ratios ('86-'94).

21. Raytheon Company

a. Solvency

Figure 3-61 displays Raytheon's solvency ratios for the period of study. The graph shows the firm to be comfortably solvent. Note the two ratio curves are mirror images of one another. This reciprocal relationship, whereby the CR trend increases while the DE trend decreases, is strong evidence of a highly solvent firm.

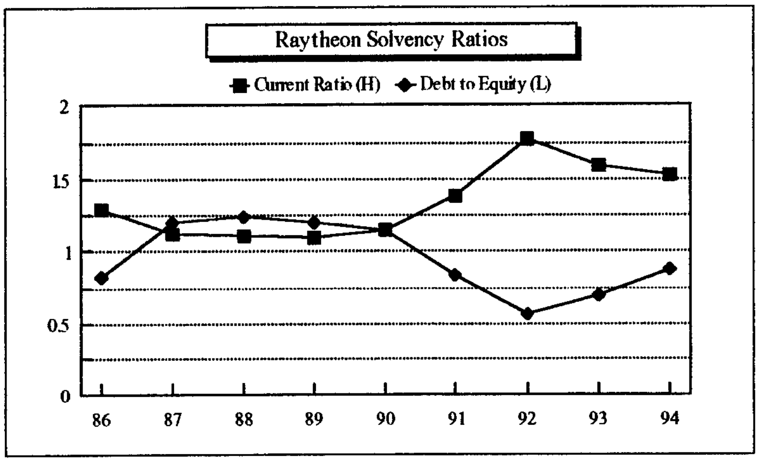

Figure 3-61. Raytheon Solvency Ratios ('86-'94).

b. Efficiency

Figure 3-62 displays Raytheon's efficiency ratios for the period of study. The efficiency ratios clearly give conflicting views of how efficient the firm's operations have been. While the CP remains stable, the ITO trend moves downward (less efficient), and the WCTA trend moves upward (more efficient).

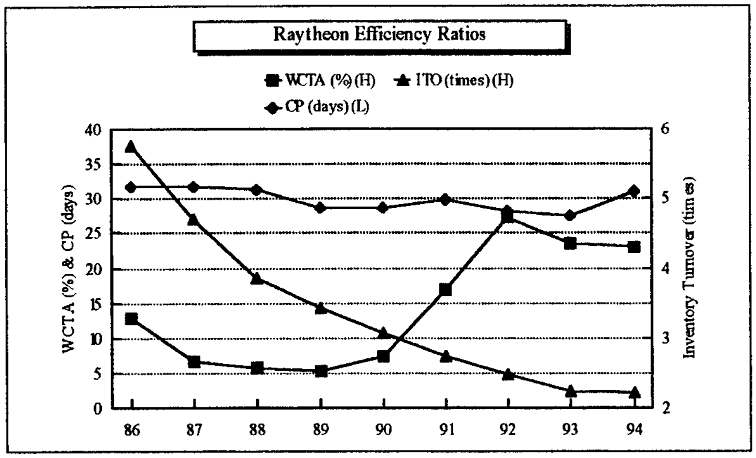

Figure 3-62. Raytheon Efficiency Ratios ('86-'94).

c. *Profitability*

Figure 3-63 displays Raytheon's profitability ratios for the period of study. Although somewhat unclear, the graph shows profitability generally declining. Although the GMR trend is indicative of slightly increasing profitability, the downward ROA and ROI trends indicate a more steep decrease in profitability.

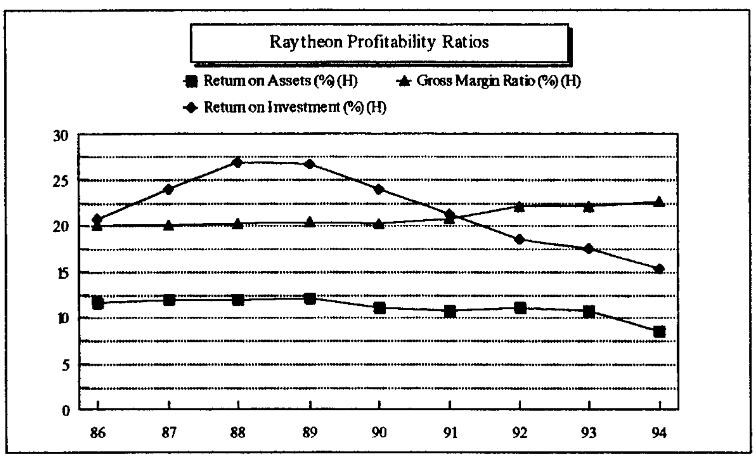

Figure 3-63. Raytheon Profitability Ratios ('86-'94).

22. Rockwell International Corporation

a. *Solvency*

Figure 3-64 displays Rockwell's solvency ratios for the period of study. While the increasing CR trend (more solvent) and DE trend (less solvent) tend to

contradict one another, the magnitude of these ratios supports the more solvent position. However, the upward CP trend (Figure 3-65) shows the firm to be potentially less solvent.

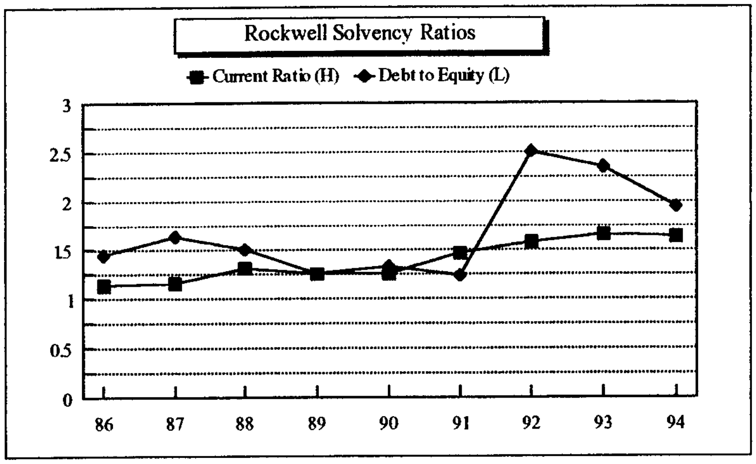

Figure 3-64. Rockwell Solvency Ratios ('86-'94).

b. Efficiency

Figure 3-65 displays Rockwell's efficiency ratios for the period of study. The previously mentioned upward CP trend (indicating less efficient operations) is countered by an upward WCTA trend (indicating more efficient operations). The ITO trend is also toward more efficient operations.

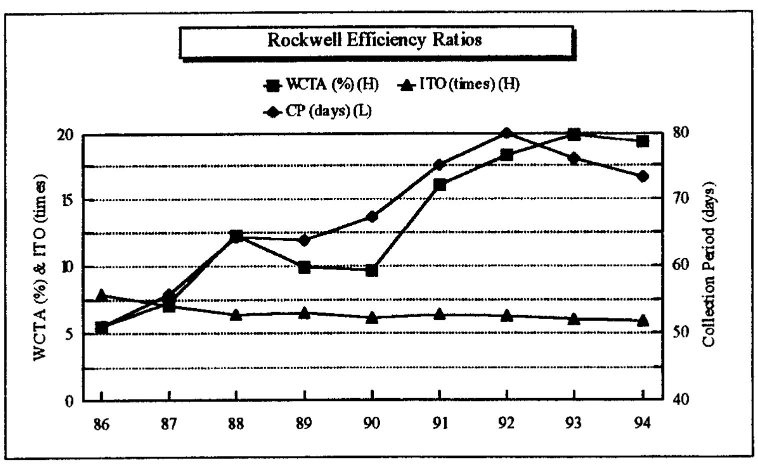

Figure 3-65. Rockwell Efficiency Ratios ('86-'94).

c. Profitability

Figure 3-66 displays Rockwell's profitability ratios for the period of study. The graph shows that the firm's profits have been relatively stable throughout the period of the drawdown.

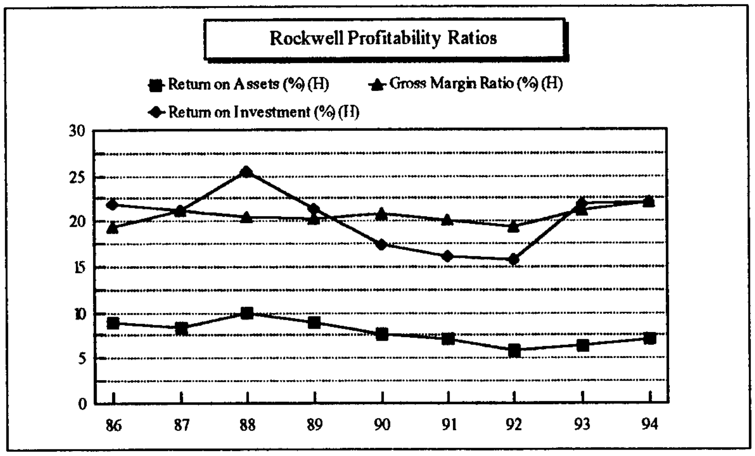

Figure 3-66. Rockwell Profitability Ratios ('86-'94).

23. Tenneco Incorporated

a. Solvency

Figure 3-67 displays Tenneco's solvency ratios for the period of study. The graph gives a mixed picture of the firm's solvency. While the upward CR trend is positive, the CR values remain relatively low. Except for an anomaly that occurred in '92, the firm's DE ratios remain fairly stable. The '92 spike on the graph was due to an accumulated deficit in retained earnings, which lowered total equity.

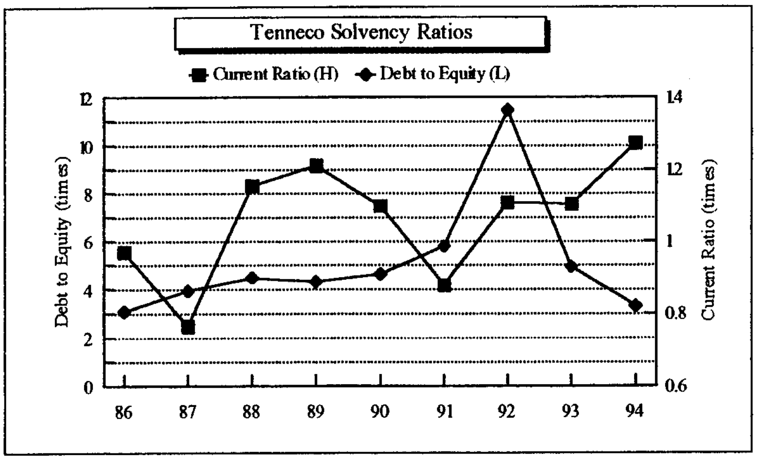

Figure 3-67. Tenneco Solvency Ratios ('86-'94).

b. Efficiency

Figure 3-68 displays Tenneco's efficiency ratios for the period of study. Like most of the sample firms, Tenneco's efficiency position is confusing. The negative working capital and low values of WCTA ratios reflect inefficiencies associated with financing ongoing operations. The firm's erratic CP ratio, which fluctuated from 35 to over 100 days, is also indicative of inefficient operations. However, the rising trend in ITO is a positive sign regarding efficiency.

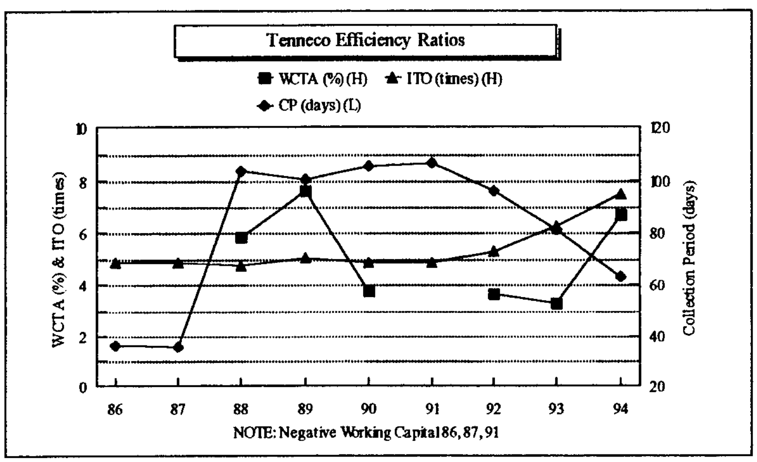

Figure 3-68. Tenneco Efficiency Ratios ('86-'94).

c. Profitability

Figure 3-69 displays Tenneco's profitability ratios for the period of study. The firm was largely unprofitable since it lost money during four of years of the study.

Although the GMR trend remains relatively steady over the span of the study, these ratios fell during the unprofitable years, thereby indicating that shrinking margins contributed to the firm's poor profitability.

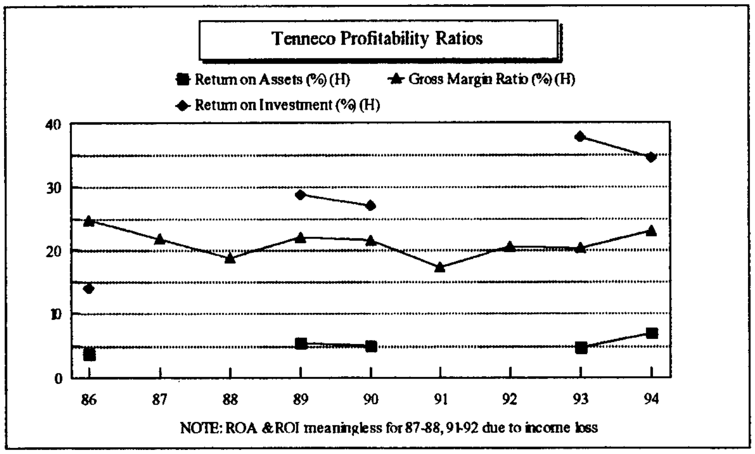

Figure 3-69. Tenneco Profitability Ratios ('86-'94).

24. Texas Instruments Incorporated

a. Solvency

Figure 3-70 displays TI's solvency ratios for the period of study. The graph (and Figure 3-71) shows the firm to be extremely solvent in terms of trends and magnitudes of all three solvency ratios.

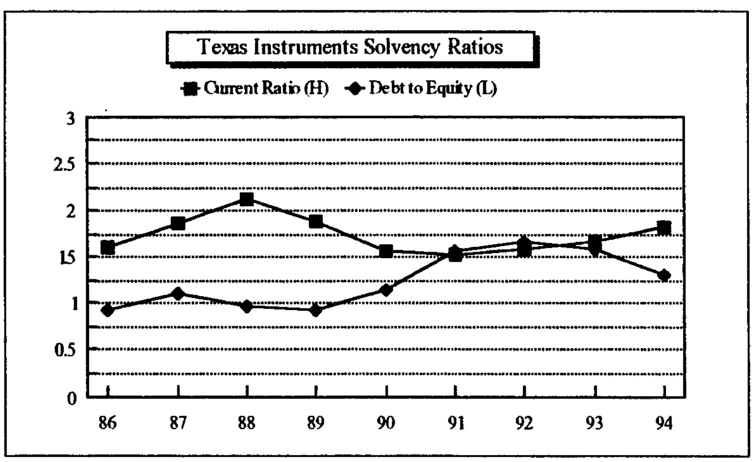

Figure 3-70. Texas Instruments Solvency Ratios ('86-'94).

b. Efficiency

Figure 3-71 displays TI's efficiency ratios for the period of study. Although there is some fluctuation, the trends of all of the firm's efficiency ratios indicate fairly efficient operations.

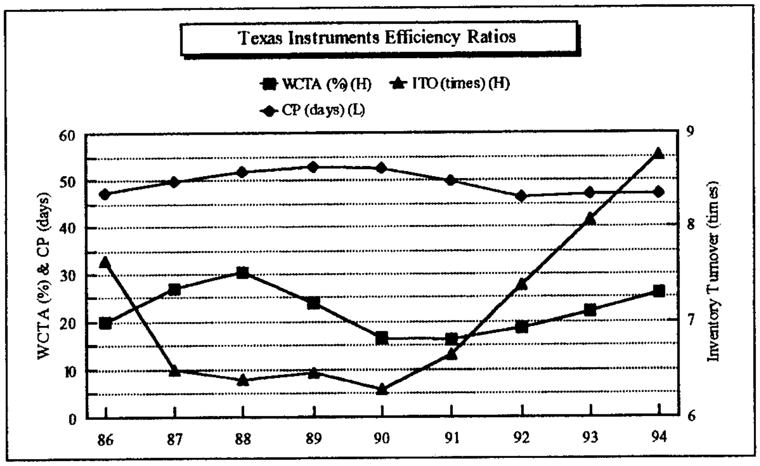

Figure 3-71. Texas Instruments Efficiency Ratios ('86-'94).

c. Profitability

Figure 3-72 displays TI's profitability ratios for the period of study. Over the period representing the defense drawdown, the firm experiences successive periods of declining profits, no profits (loss on net income), and increasing profits.

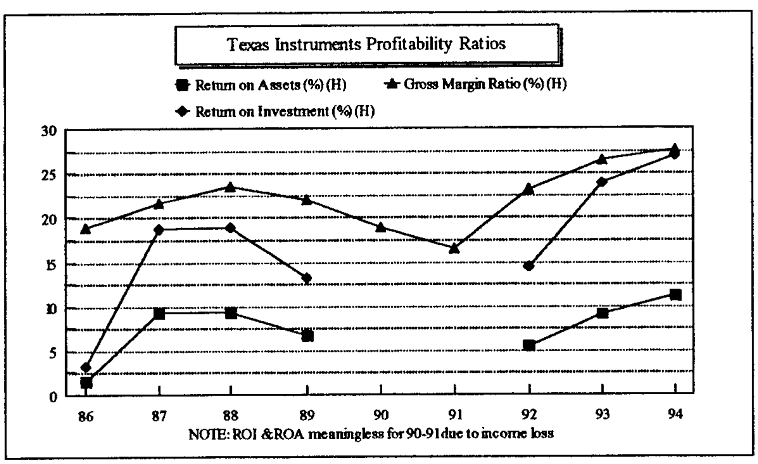

Figure 3-72. Texas Instruments Profitability Ratios ('86-'94).

25. Textron Incorporated

a. Solvency

Figure 3-73 displays Textron's solvency ratios for the period of study. The trends of both the CR and DE ratios indicate the less solvent position in which the firm has operated. Most alarming is the magnitude of the growth of the firm's debt relative to its equity. Note however, that Figure 3-74 shows a declining CP, thus supporting a more solvent operating position.

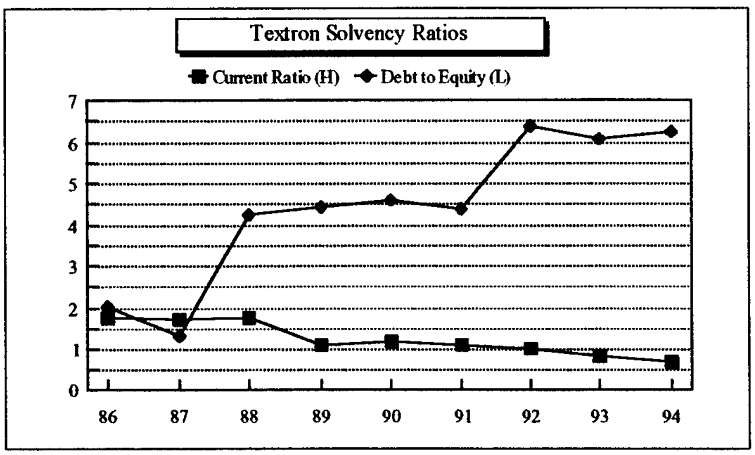

Figure 3-73. Textron Solvency Ratios ('86-'94).

b. Efficiency

Figure 3-74 displays Textron's efficiency ratios for the period of study. Once again the efficiency ratios support different efficiency positions. As noted above, the declining CP also indicates more efficient operations, but the negative working capital, and declining WCTA indicate less efficient operations. The ITO remains stable.

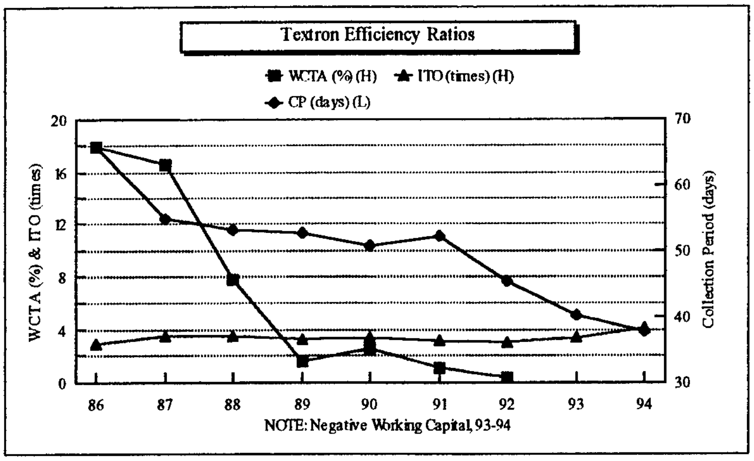

Figure 3-74. Textron Efficiency Ratios ('86-'94).

c. *Profitability*

Figure 3-75 displays Textron's profitability ratios for the period of study. Although the firm's profitability is clearly established, the graph shows a slight decrease in ROA, but a healthy increase in ROI. GMR remains relatively stable.

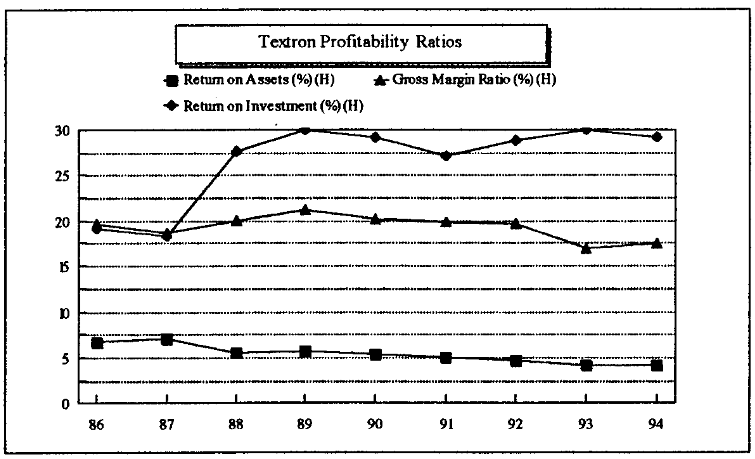

Figure 3-75. Textron Profitability Ratios ('86-'94).

26. Unisys Corporation

a. *Solvency*

Figure 3-76 displays Unisys' solvency ratios for the period of study. Although the magnitudes do not support the position, the upward DE trend indicates a less solvent position. However, this is tempered by the stable CR values and declining CP values (see Figure 3-77).

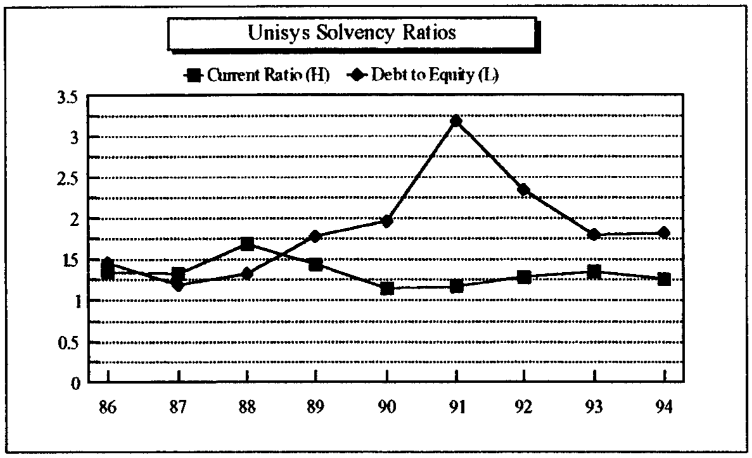

Figure 3-76. Unisys Solvency Ratios ('86-'94).

b. Efficiency

Figure 3-77 displays Unisys' efficiency ratios for the period of study. Since '88, the firm's downward CP trend and upward ITO trend indicate fairly efficient operations regarding collection of receivables and turnover of inventory. However, the downward WCTA trend is indicative of less efficient operations regarding the funding available for ongoing operations.

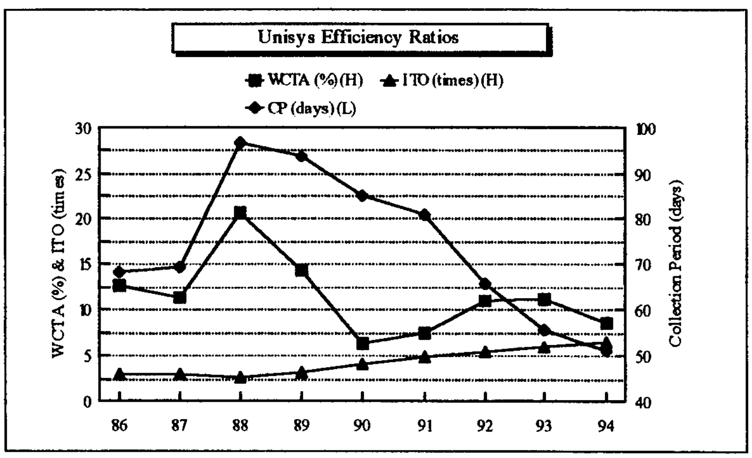

Figure 3-77. Unisys Efficiency Ratios ('86-'94).

c. Profitability

Figure 3-78 displays Unisys' profitability ratios for the period of study. The company lost money during the years '86 and '89-'91. This poor profitability position is

also shown by decreased values for the GMR for these years. Since profitability is reestablished in '92, all three ratios decline steadily.

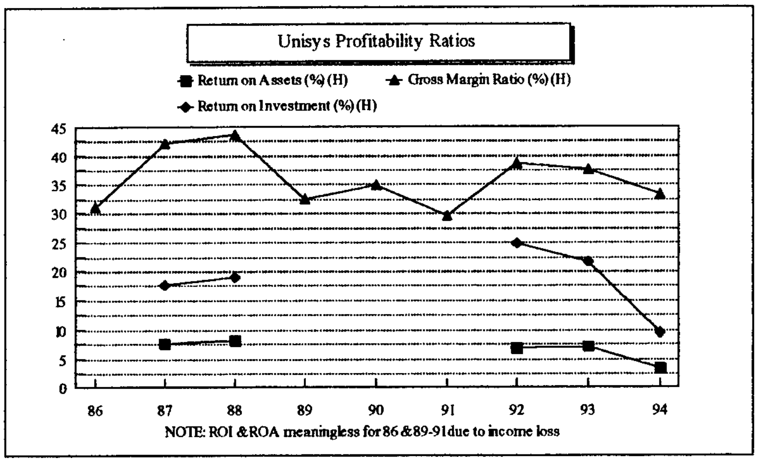

Figure 3-78. Unisys Profitability Ratios ('86-'94).

27. United Technologies Corporation

a. Solvency

Figure 3-79 displays UTC's solvency ratios for the period of study. Although the upward DE trend might indicate a less solvent position, the magnitudes of the DE ratios indicate the firm's solvency is of little concern. The CR trend is steady and over 1.0 in magnitude, thus indicating a relatively solvent position.

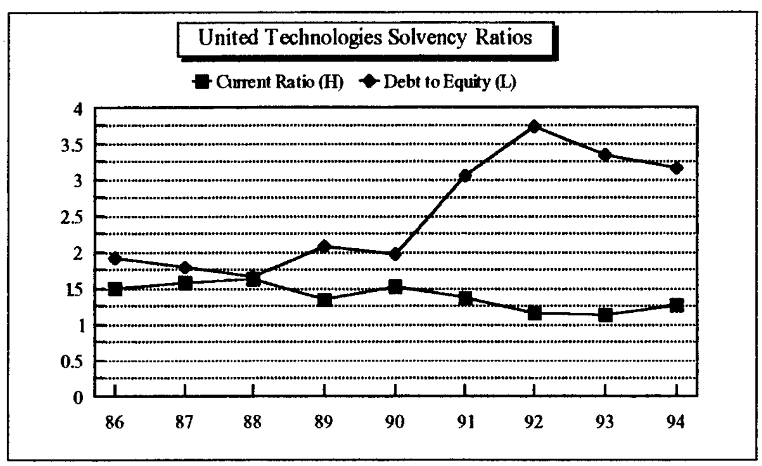

Figure 3-79. United Technologies Solvency Ratios ('86-'94).

b. Efficiency

Figure 3-80 displays UTC's efficiency ratios for the period of study. The steady trend in CP values, and the increasing ITO trend support an efficient operating position, whereas the declining WCTA trend provides evidence to the contrary.

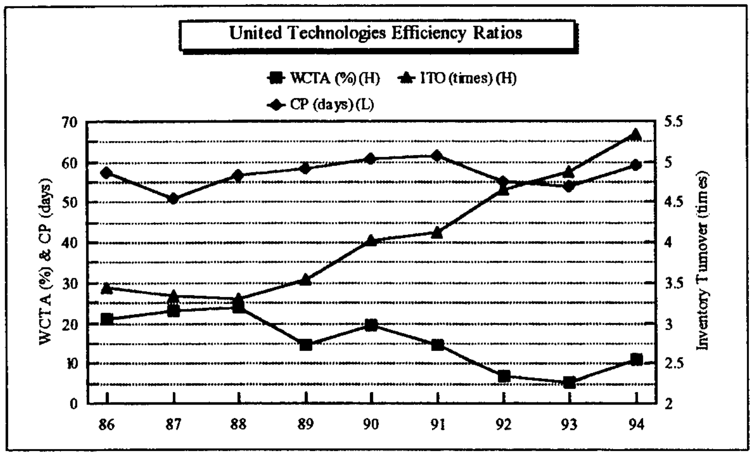

Figure 3-80. United Technologies Efficiency Ratios ('86-'94).

c. Profitability

Figure 3-81 displays UTC's profitability ratios for the period of study. The firm experienced low returns in '86 and '92, and losses in '91. However, all three profitability ratios increase over the last three years of the study.

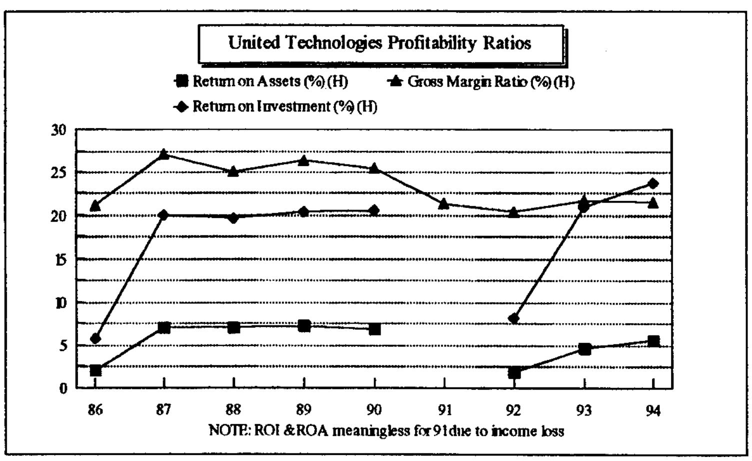

Figure 3-81. United Technologies Profitability Ratios ('86-'94).

28. Westinghouse Electric Corporation

a. Solvency

Figure 3-82 displays Westinghouse's solvency ratios for the period of study. The graph is unclear concerning the firm's solvency. Except for '91, when the CR dropped below 1.0, the upward CR trend indicates relative solvency. However, the upward DE trend is contrary to such a position. The large increase in the DE ratio in '93 was due mostly to pension liabilities.

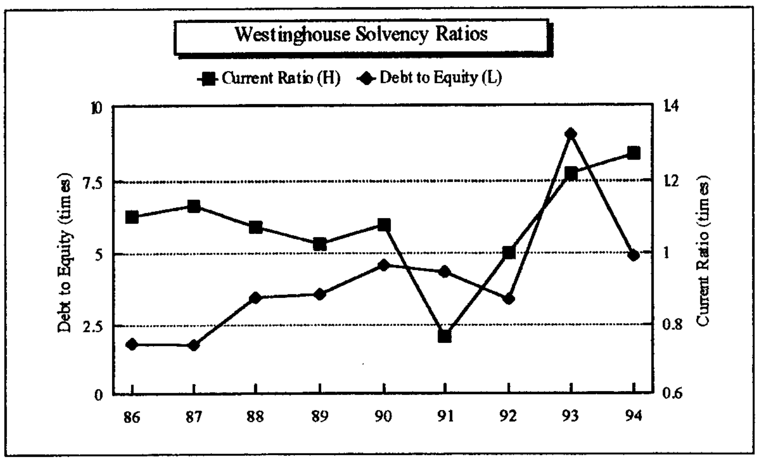

Figure 3-82. Westinghouse Solvency Ratios ('86-94).

b. Efficiency

Figure 3-83 displays Westinghouse's efficiency ratios for the period of study. The three curves move downward through '91, thus providing a mix of efficiency indicators. While the declining WCTA and ITO trends indicate less efficient operations over this period, the declining CP is a sign of more efficient operations. Although WCTA ratios climbed after '92, their values are still relatively low. The upward CP trend experienced by the firm since '91 is further indicative of increasing efficiency.

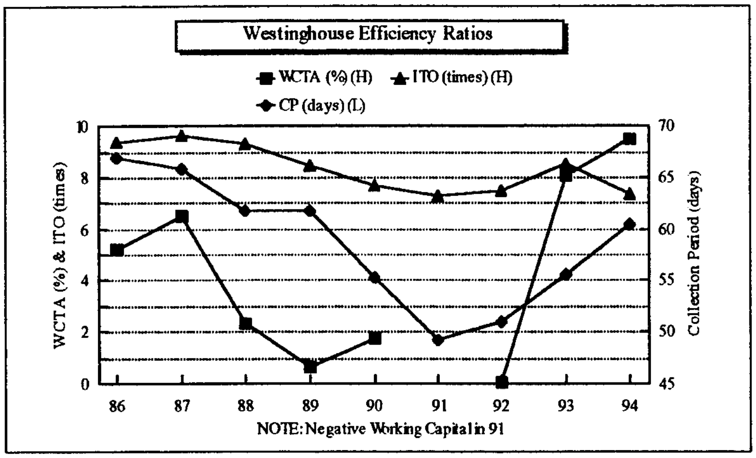

Figure 3-83. Westinghouse Efficiency Ratios ('86-'94).

c. *Profitability*

Figure 3-84 displays Westinghouse's profitability ratios for the period of study. The company lost money in '91 and '93. The downward ROI and ROA trends further indicate declining profitability. Due to the fact that the shape of the GMR curve, since '90, is equivalent to that of the ROI and ROA, the declining trend in profitability over the latter half of the study is due to declining net sales and/or growing costs of goods and services sold. This means that the declining ROA and ROI values are due to lower net income (the numerator), more so than changes in assets and equity respectively.

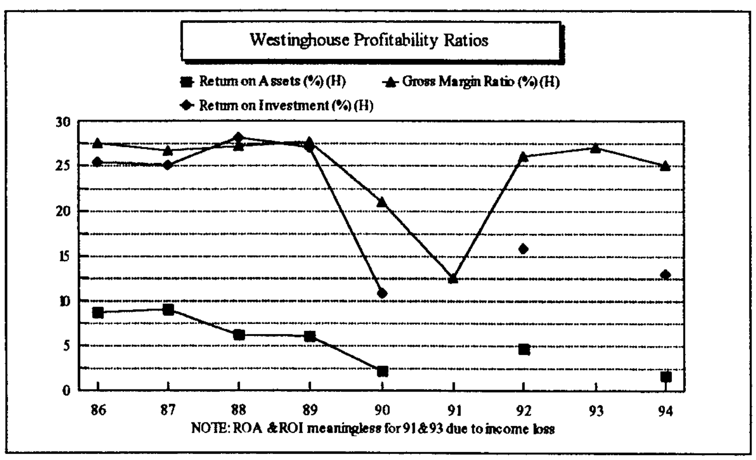

Figure 3-84. Westinghouse Profitability Ratios ('86-'94).

IV. COMPARATIVE ANALYSIS

A. SAMPLE STRATIFICATION

As previously stated, financial ratios, such as those presented in the previous chapter, find their analytical utility only when compared to other such ratios. In order to facilitate this comparative analysis, it was necessary to separate the sample firms by line of business (or SIC), and by level of past, existing, and future defense industry participation.

1. Classification by Standard Industrial Classification (SIC) Code

To better understand the business environments in which the sample defense firms operate, it was first necessary to identify which products and services they each provided for their various customers. Corporate annual reports were a good source for such information as provided in Chapter II. While this information was good for background and discussion, more definite line of business (SIC) information was required for the graphical and statistical analyses. In order to prevent comparisons of "apples and oranges" during these analyses, the sample was stratified by four-digit SIC codes. The results of this sample classification effort not only demonstrated the great diversity of products and services provided by these firms, but also identified the SICs in which the majority of the firms operated.

The source consulted for SIC classification was *S&P's Register of Corporations, Directors and Executives* [Ref. 49]. First of all, the Ultimate Parent Index in Volume 3 of this reference was used to identify the divisions and subsidiaries of each firm. Volume 1, Corporations, was then used to identify the various SICs in which each of these business units participated. These data were then gathered into a Lotus 1-2-3 spreadsheet, and appear in the Appendix. The "P", "S", and "D" in the spreadsheet indicate whether the line of business was conducted by the parent company, and/or a subsidiary, and/or a division of the parent company respectively. This information was used to identify the four-digit SICs in which many (if not most) of the sample firms operated. These twelve

SICs, identified in Table 2-3, were considered most representative of the various business lines of defense firms. As mentioned in Chapter II, selected financial ratios of sample firms operating in these particular SICs were graphically compared to the manufacturing industry *norms* for these ratios. The results of this graphical analysis appear in Section B below. However, two of the SICs in which many of the sample firms operated -- 3761 Guided Missiles and Space Vehicles; and 3769 Space Vehicle Equipment, Not Elsewhere Classified (NEC) -- were not included in this analysis since industry norms for these SICs could not be found. The absence of industry norms (median and quartile values) for these SICs is indicative of the fact that only a statistically insignificant few firms operate in them.

2. Classification by Level of Defense Industry Participation

In order to evaluate the corporate strategic aspects of the defense drawdown, it was necessary to further classify the sample firms as either *defense-dependent* or *defense-indifferent*. Although somewhat more arbitrary than the previous classification by SIC, this classification was conducted using three criteria: the Value Line industry classification of each firm; the relative amounts of Government/defense versus commercial business conducted by each firm; and the firms' strategies toward past, present and future participation in the defense industry. Firms which were classified as members of the aerospace/defense industry, or received over one-third of their sales revenues from DoD, and expressed a strategy continuously reliant upon defense business were classified as defense-dependent. Those firms which were otherwise classified, received less than one-third of their business from defense, and expressed a strategy favoring increasing commercial business at the expense of defense business were classified as defense-indifferent. The one-third of sales figure was selected because it enabled a clear stratification when the other two criteria favored mixed outcomes. Table 4-1 below indicates the sample classification according to these criteria. While some might argue the resulting classification regarding firms which are "on the margin", it is the result of the reasonably-applied criteria of this researcher. This information was used during the two-sample hypothesis testing conducted later in this chapter.

Defense-Dependent Firms	Defense-Indifferent Firms
Boeing	General Electric
E-Systems	General Motors
FMC	GTE
General Dynamics	Honeywell
Grumman	IBM
Harris	ITT
Litton	LTV
Lockheed	Motorola
Loral	Tenneco
Martin Marietta	Texas Instruments
McDonnell Douglas	Textron
Northrop	Unisys
Raytheon	United Technologies
Rockwell International	Westinghouse

Table 4-1. Defense Dependence Classification of Sample.

B. VISUAL/GRAPHICAL ANALYSIS

The figures in this section graphically portray the sample medians (along with the industry norms) for four different financial ratios, and the twelve SICs most commonly operated in by the sample defense firms. The terms in the legends of the graphs (UQ, NORM, MEDIAN, and LQ) refer to the upper quartile, industry norm (median), sample median, and lower quartile values for the various ratios respectively. The industry norm, UQ, and LQ values were provided by D&B's *Industry Norms & Key Business Ratios* [Ref. 6], and are representative of all U.S. manufacturing firms operating in the selected SICs. Recall that the UQ refers to a more favorable condition (value) regarding a particular ratio, and the LQ refers to a less favorable one. The graphs indicate which condition (higher or lower) is more favorable for each ratio. The sample median values were derived from only those firms conducting business within the selected SICs. The graphs for each of the twelve SICs are preceded by an evaluation of the graphical comparison regarding trends and sample comparison with industry values. The financial ratios chosen for the graphical analysis were the current ratio (CR), debt to equity (DE), collection period (CP), and return on assets (ROA). Recall that CR and DE ratios are indicative of a firm's solvency, while the CP is indicative of both a firm's solvency and efficiency. The ROA ratio is representative of a firm's profitability.

1. SIC 3571: Electronic Computers

a. Current Ratio (CR)

Figure 4-1 shows that, over the period of study, the sample defense firms are less solvent than the LQ of all U.S. firms manufacturing this product (i.e., the sample defense firms are less solvent than three-quarters of all U.S. manufacturers). However, the CR trend over the period of the drawdown is downward toward a less solvent position industry-wide.

b. Debt to Equity (DE) Ratio

Similarly, the DE graph shows that, over the period of study, the sample firms are less solvent than three-quarters of all U.S. manufacturers of electronic computers. However, during the latter three years of study, median DE improves toward the norm, while the trend for the rest of U.S. manufacturing is upward toward a less solvent position.

c. Collection Period (CP)

Although the sample defense firms performs below average (i.e., worse than the industry norm) over most of the period of study, during the latter years of study, median CP improves toward the industry average. The industry CP trend moves downward toward a more efficient operating position.

d. Return on Assets (ROA)

Over the period of study, the sample firms mirror the industry average values for ROA, thus moving in equal magnitude, in the opposite direction, along the same trend. Note that the LQ ROA values are negative for most of the period, thus indicating that nearly one-forth of all U.S. firms in this line of business lost money over the period of study.

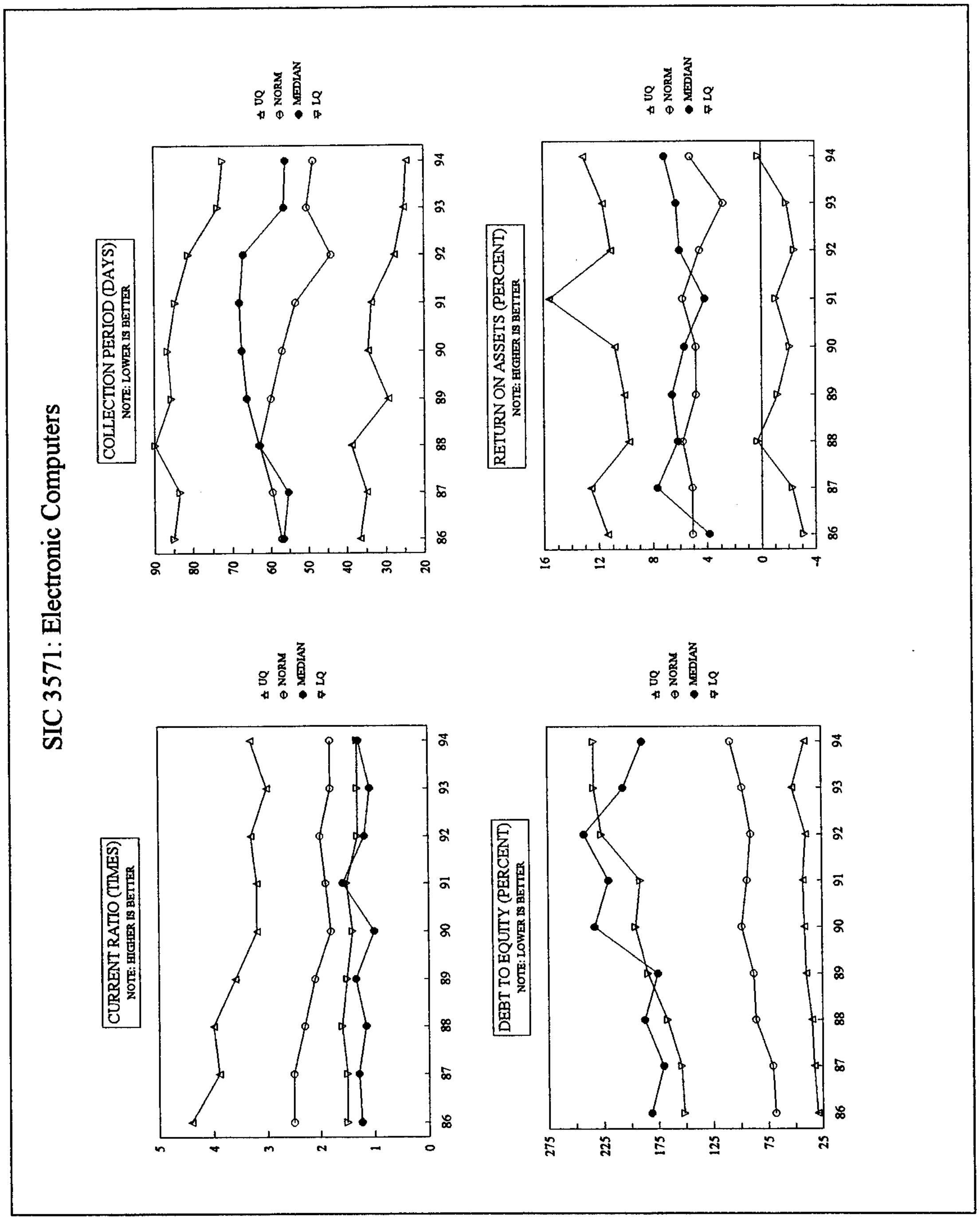

Figure 4-1. Graphical Analysis of SIC 3571: Electronic Computers.

2. SIC 3577: Computer Peripheral Equipment, NEC

a. Current Ratio (CR)

Figure 4-2 shows that the sample defense firms were less solvent than over three-quarters of all U.S. manufacturing firms in this line of business, as the sample median fell below the LQ for most of the period of study. The CR trend for all computer peripheral manufacturers over the period of study was upward toward a more solvent position. However, the sample median remained stable with a magnitude of just over 1.

b. Debt to Equity (DE) Ratio

Once again, the sample defense firms appeared to be less solvent than most U.S. manufacturers within this SIC. Although the sample median DE showed fluctuation, its trend was upward toward a less solvent position, while the industry norms varied very little, and moved downward toward increased solvency.

c. Collection Period (CP)

Regarding efficiency of collection of receivables, the graph shows that the sample firms were, on average, less efficient than U.S. manufacturers, at large. The CP trend for the sample defense firms moved upward toward less efficient operations, while the industry norms generally moved downward toward more efficient operations over the period of study.

d. Return on Assets (ROA)

Over the span of the drawdown, the sample median ROA and the industry norm were virtually the same. This ratio demonstrated a large dispersion of returns among industry participants, as evidenced by the large difference between the LQs (negative or less than 2%) and the UQs (moving steadily upward from 9% to 18%). The fluctuation shown in the curves indicate highly variable profitability among firms operating in this SIC.

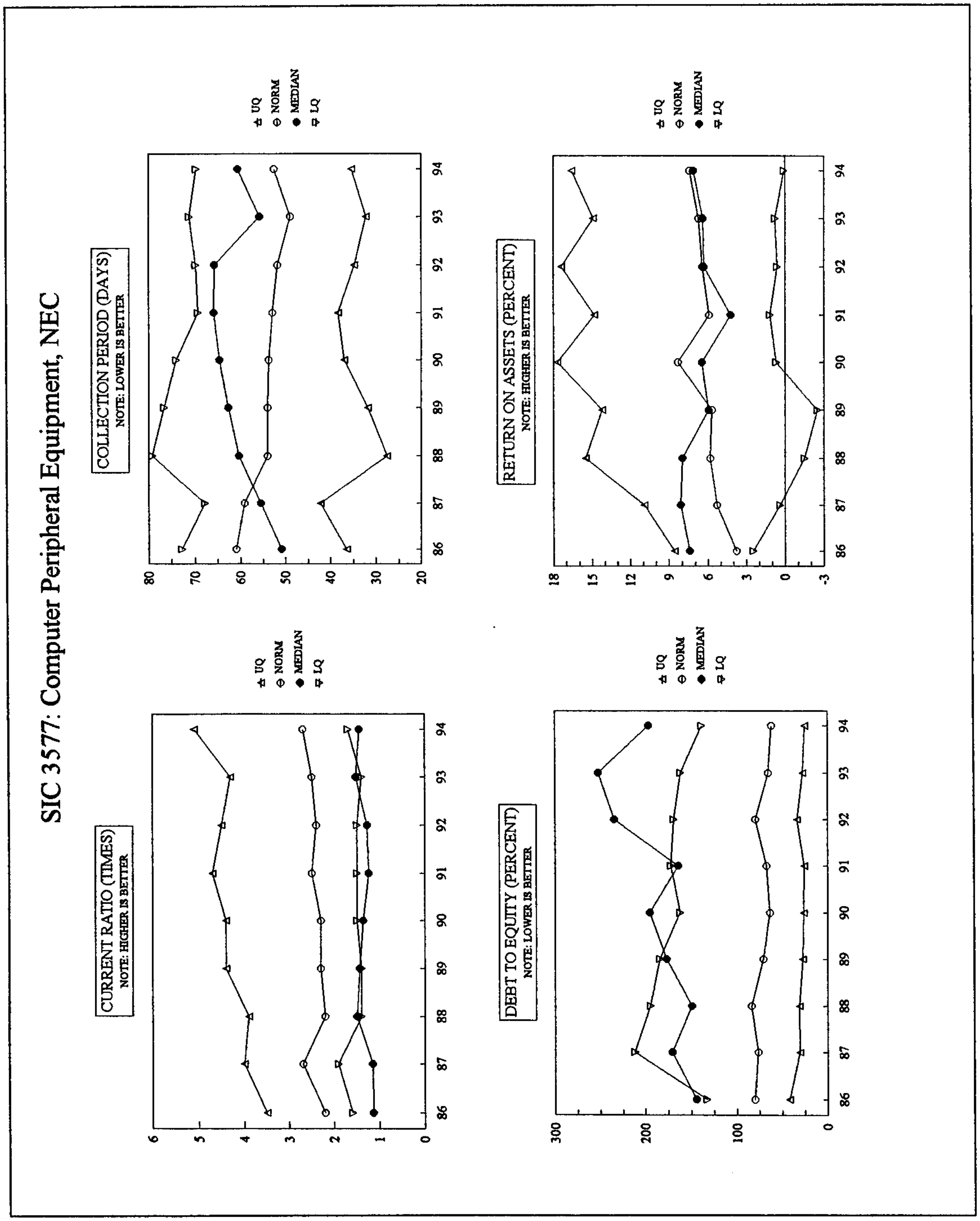

Figure 4-2. Graphical Analysis of SIC 3577: Computer Peripheral Equipment, NEC.

3. SIC 3661: Telephone and Telegraph Apparatus

a. Current Ratio (CR)

Figure 4-3 shows that the median CRs of the sample defense firms were equivalent to the LQs, thus indicating that, over the period of the drawdown, defense firms were less solvent than three-quarters of all U.S. firms operating within this line of business. While these average CR values (sample median and LQ) remained steady with values around 1.5, the firms in the UQ showed extremely solvent CR values, many of which were over 4. However, the CR trend among these UQ firms was downward toward decreasing solvency, while the industry norm remained relatively steady at magnitudes above 2.

b. Debt to Equity (DE) Ratio

The sample median DE ratios were above the industry median throughout the period of study, and were higher than the LQ values over the last three years of the drawdown. This indicates that the sample defense firms operated less solvently than the majority of U.S. firms within this business line. While the trends for the industry DE ratio norms (UQ, LQ, and median) were relatively stable over the period of study, the DE ratio trend for the sample rose toward a less solvent position.

c. Collection Period (CP)

The graph shows that the sample defense firms performed better than average at collecting their receivables over the early years of the study. Although the trend for the sample median CP moved upward, indicating less efficient operations over time, the sample defense firms performed more efficiently than the LQ throughout.

d. Return on Assets (ROA)

With the median ROAs between the industry norm and UQ, the profitability of sample defense firms within this line of business was above average. Although many of the LQ firms operated at losses for much of the period, the ROA trends within the industry were upward toward more profitable positions. However, the ROA trend for the sample defense firms remained steady at values above 5%.

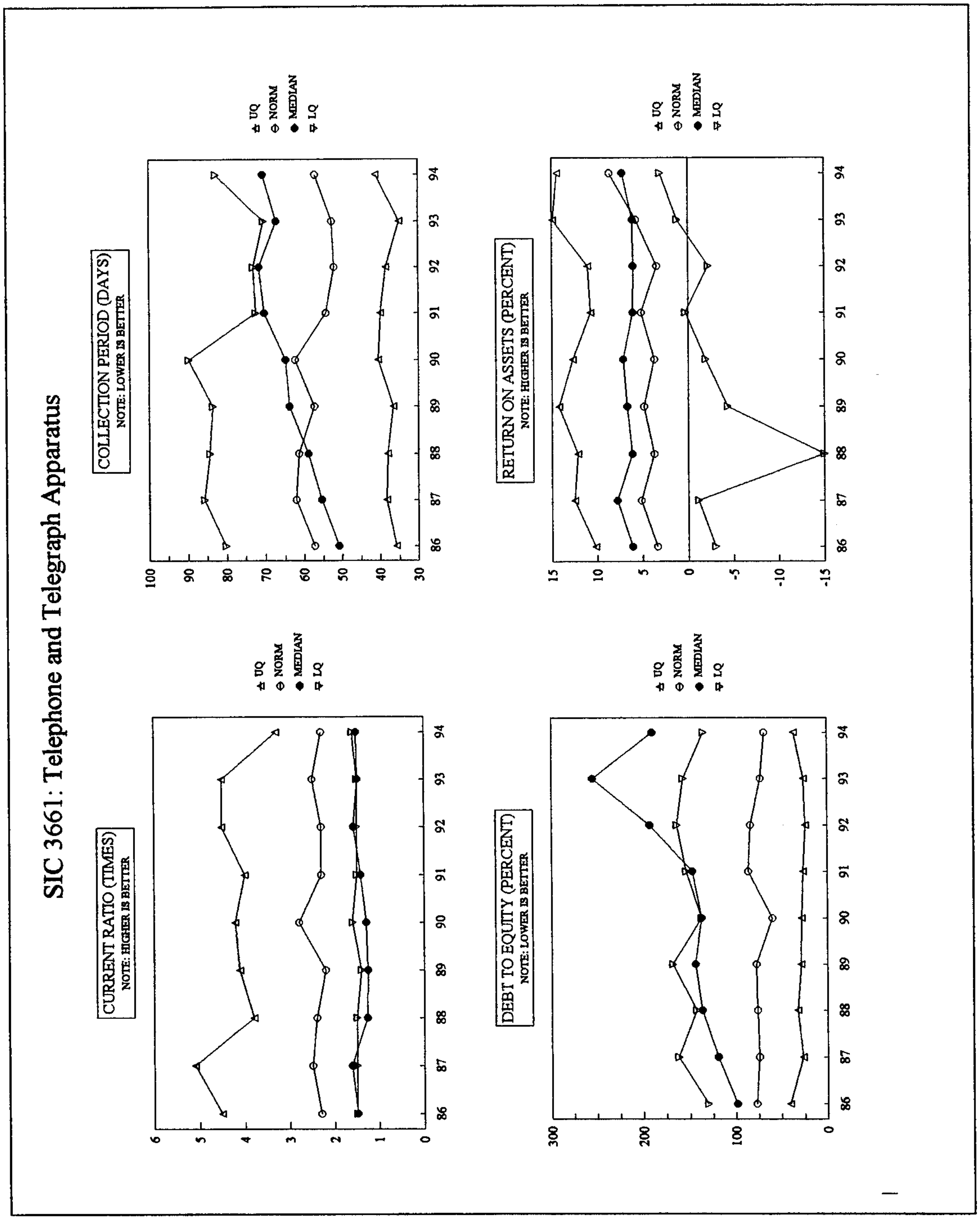

Figure 4-3. Graphical Analysis of SIC 3661: Telephone and Telegraph Apparatus.

4. SIC 3663: Radio and TV Communications Equipment

a. Current Ratio (CR)

Figure 4-4 shows that the sample defense firms operated in less solvent positions than three-quarters of all radio and TV equipment manufacturers, as the sample median CRs were at or below the LQs throughout the study. The trends for all CR curves appears level, indicating steady solvency conditions among firms within this SIC.

b. Debt to Equity (DE) Ratio

After the first two years of the study, the operating positions of the sample defense firms were considerably less solvent than the industry standards for this business line. While the DE trends for all three industry norms remained relatively level, the sample median DE trend climbed rapidly between '86 and '89, and remained at fairly high (less solvent) values for the remainder of the period.

c. Collection Period (CP)

While the graph indicates that the operating efficiency of sample defense firms was below the industry average for much of the period of the drawdown, it shows improved efficiency for these firms during the last two years of study. The industry CP trends were relatively level, with half of all firms operating within the SIC collecting receivables within 35 to 80 days. The CPs for the sample defense firms varied between 50 and 70 days.

d. Return on Assets (ROA)

The sample firms achieved profitability levels equivalent to the industry averages over the span of the study. The average ROA values fluctuated between 5% and 7% for both the industry and sample medians. The graph shows a great deal of fluctuation in the ROA values of UQ and LQ firms, which indicates highly variable profitability among firms operating in this SIC.

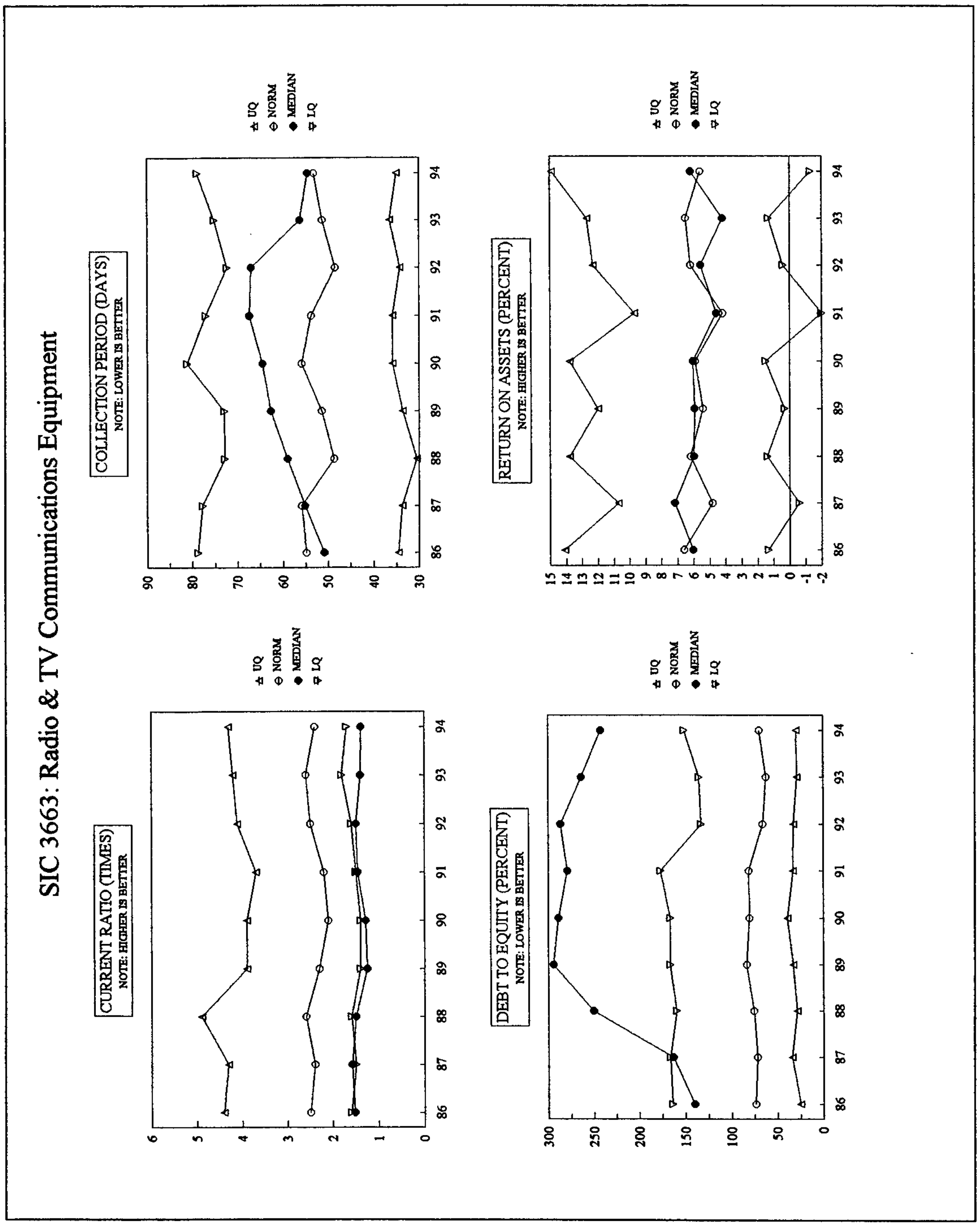

Figure 4-4. Graphical Analysis of SIC 3663: Radio and TV Communications Equipment.

5. SIC 3669: Communications Equipment, NEC

a. Current Ratio (CR)

Figure 4-5 shows that the sample defense firms operate in less solvent positions than three-quarters of all firms which operate within this line of business, as the sample median CRs are at or below the LQs throughout the study. Except for a sudden upward spike in UQ in '93, the trends for all CR curves appear level, indicating steady solvency conditions among firms within this SIC.

b. Debt to Equity (DE) Ratio

With the sample median DE falling between the industry median and the LQ throughout the period, the graph indicates that the defense firms operating within this SIC achieved below average solvency levels. Although the graph shows some variability in the DE ratios of LQ firms, the relatively level DE trends of the industry norms and UQs indicate steady solvency conditions within this business line.

c. Collection Period (CP)

The graph indicates that, regarding CP, the sample defense firms performed with average efficiency over the period of study. While there is some fluctuation among industry norm, UQ and LQ CP values over the nine year period, the magnitude of this variability is only 10 days, thus indicating that operating efficiency within this industry was fairly stable.

d. Return on Assets (ROA)

The graph shows that sample defense firms achieved average levels of profitability over the period of the study, as the sample median and industry norm ROAs were approximately equivalent. While the trends for all ROA curves increased upward slightly, ROAs for UQ firms varied between 11% and 18%, and ROAs for LQ firms varied equally between low and no returns.

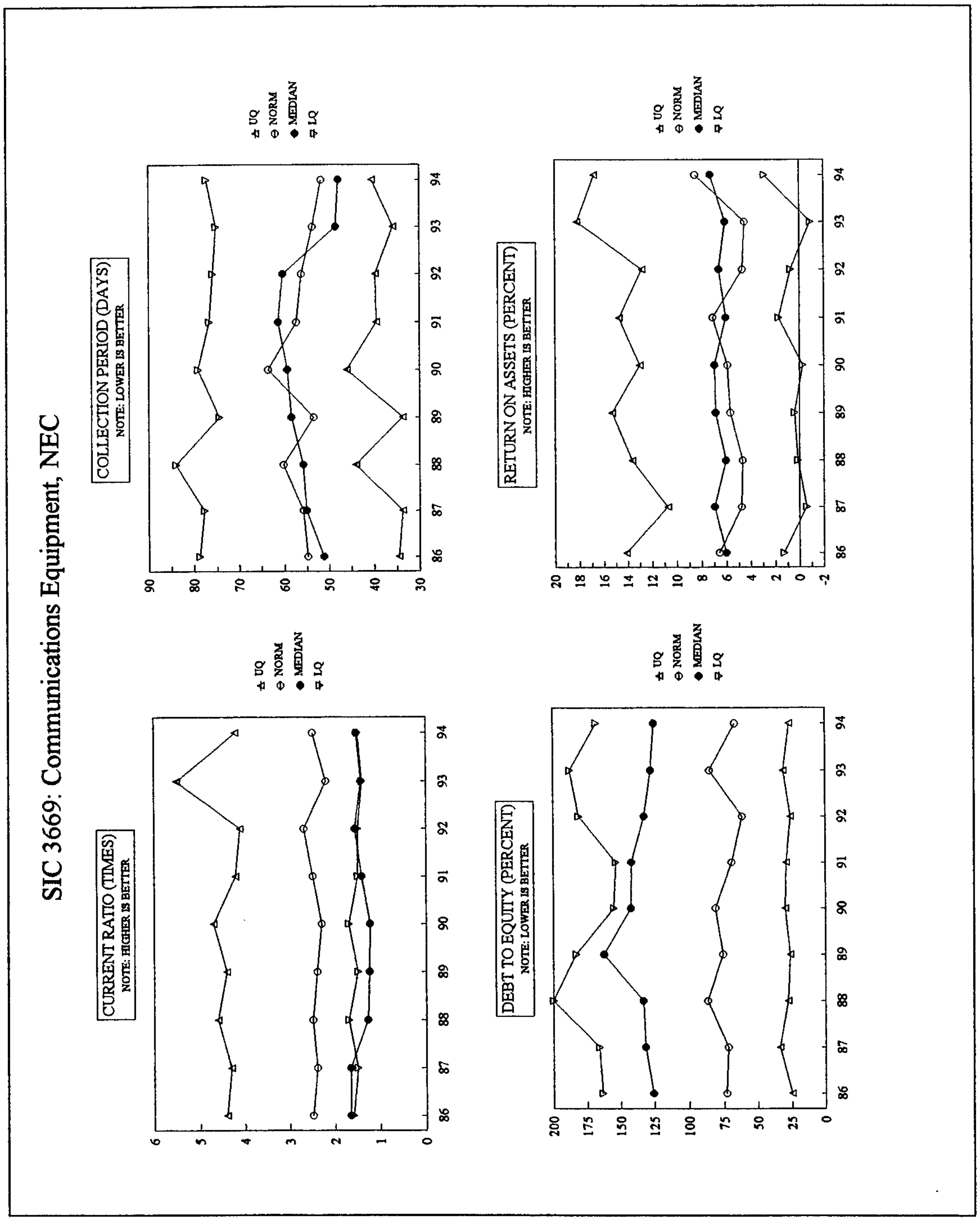

Figure 4-5. Graphical Analysis of SIC 3669: Communications Equipment, NEC.

6. SIC 3674: Semiconductors and Related Devices

a. Current Ratio (CR)

Figure 4-6 shows that the sample defense firms operated in less solvent positions than three-quarters of all firms which operated within this line of business, as the sample median CRs were at or below the LQs throughout the study. The trends for all CR curves appear level, indicating steady solvency conditions among firms within this SIC.

b. Debt to Equity (DE) Ratio

The graph indicates that the sample defense firms were less solvent than the average firm operating within this SIC, as sample median DEs were at or above the LQs throughout the study. While the graph shows a trend toward improving solvency among LQ firms, it shows an upward trend toward decreasing solvency among sample defense firms.

c. Collection Period (CP)

The graph indicates that the operating efficiency of sample firms was slightly below average throughout most of the period of study. However, their efficiency at collecting receivables improved to slightly above average during the last two years of study. Although there is some fluctuation, the CP trends are relatively stable throughout.

d. Return on Assets (ROA)

The graph shows above average profitability among the sample defense firms throughout the period of the drawdown. Although the profitability of LQ firms was poor to non-existent, the trend for this and all ROA curves moved upward toward increased profitability within the semiconductor industry.

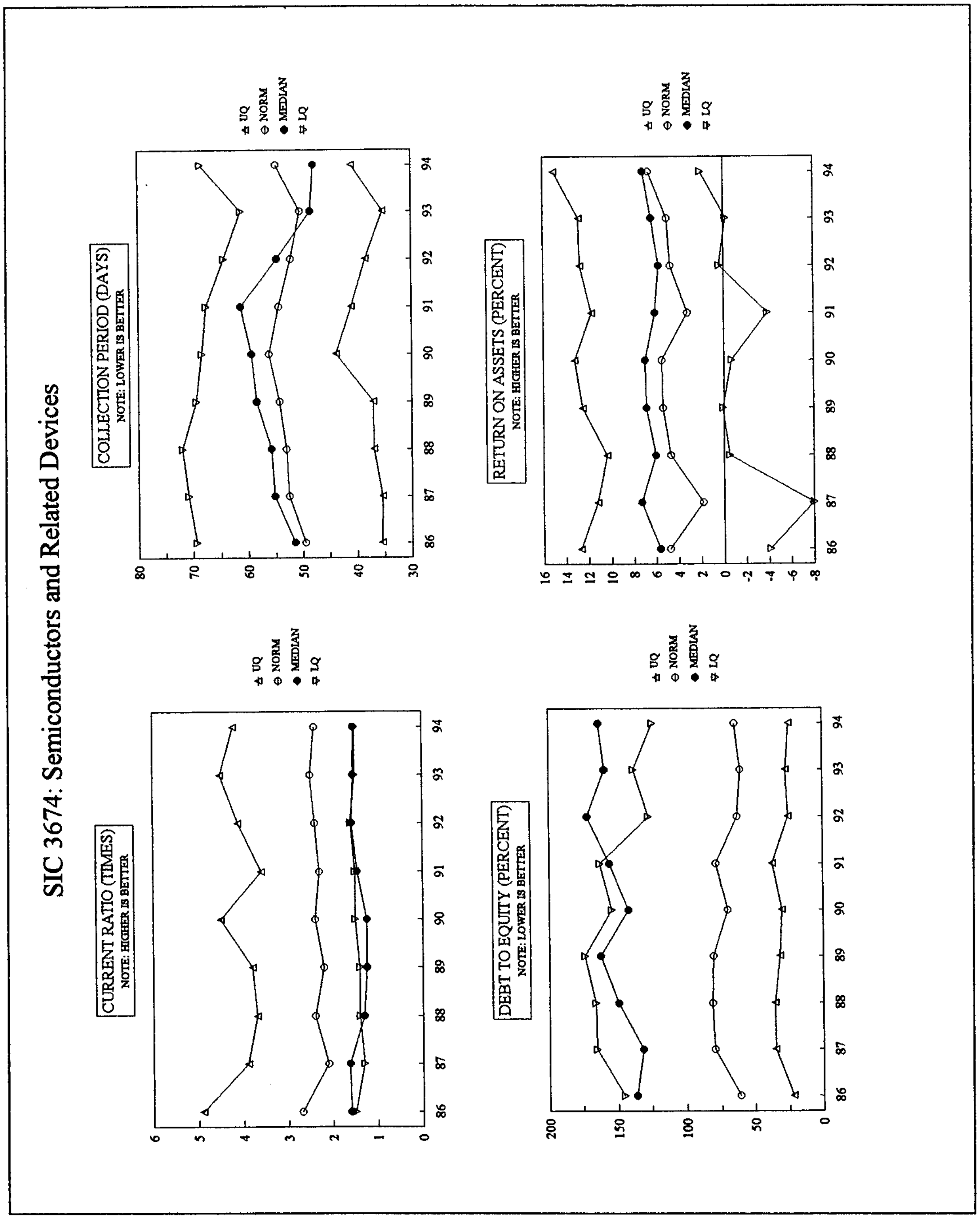

Figure 4-6. Graphical Analysis of SIC 3674: Semiconductors and Related Devices.

7. SIC 3679: Electronic Components, NEC

a. Current Ratio (CR)

Figure 4-7 shows that the sample defense firms operated in less solvent positions than three-quarters of all firms which operated within this line of business, as the sample median CRs were at or below the LQs throughout the study. The trends for all CR curves appear level, indicating steady solvency conditions among firms within this SIC.

b. Debt to Equity (DE) Ratio

The graph shows that the solvency for the sample firms went from below average to well below average over the period of study. While the DE trends for the three industry averages were steady, the DE trend for sample firms moved upward indicating decreasing solvency over the duration of study.

c. Collection Period (CP)

Although the average CPs for the sample firms are approximately average at the beginning and end of the drawdown, the graph indicates decreasing efficiency over the first half of the period and increasing efficiency over the latter half. The CP trends among all U.S. manufacturers within this SIC are level, indicating steady operating efficiency with average CPs below 50 days.

d. Return on Assets (ROA)

The graph shows that the sample defense firms achieved average profitability throughout the period of study. The level to slightly increasing industry ROA trends, and the fact that all LQs are positive values, indicates sound profitability among participants within this line of business.

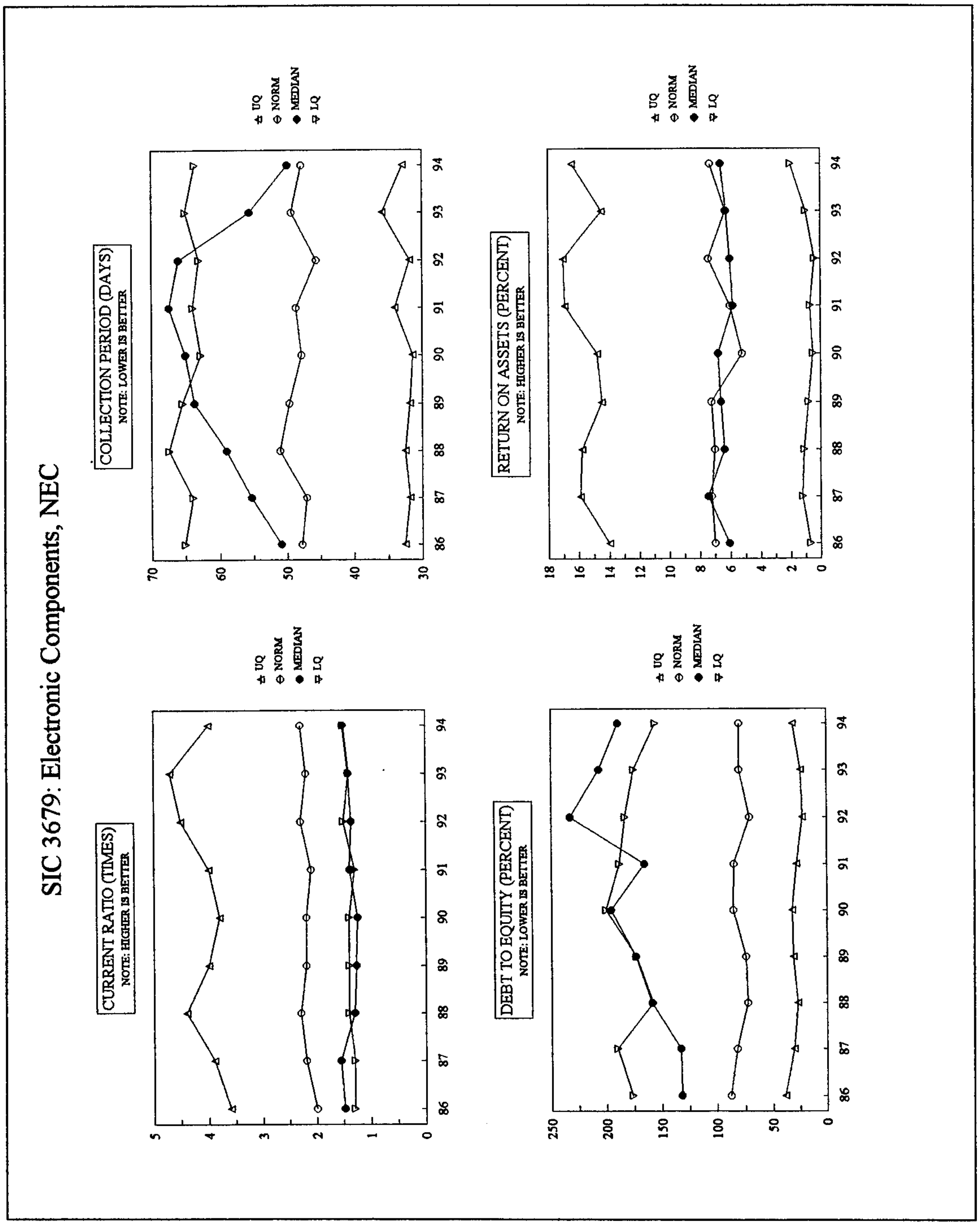

Figure 4-7. Graphical Analysis of SIC 3679: Electronic Components, NEC.

8. SIC 3699: Electrical Equipment and Supplies

a. Current Ratio (CR)

Figure 4-8 shows that the sample defense firms operated in less solvent positions than three-quarters of all firms which operated within this line of business, as the sample median CRs were at or below the LQs throughout the study. The trends for the industry norm and LQ CR curves appear level to slightly increasing, indicating steady to increasing solvency conditions among firms within this SIC. This industry position is reinforced by the UQ curve which increases upward more steeply, indicating extremely improving conditions among the more solvent firms.

b. Debt to Equity (DE) Ratio

The graph shows that, compared to average firms operating within this SIC, the sample defense firms were extremely less solvent and more debt laden. The magnitudes and trends of the industry norm, LQ, and UQ curves reflect stable and extremely solvent operating conditions among participating firms.

c. Collection Period (CP)

The graph indicates that, with regard to the collection of receivables, the sample defense firms operated with slightly below average efficiency over the period of study. Note however, that the industry CP trends moved slightly upward toward less efficient positions, while the CP trend for the sample firms indicates improving efficiency.

d. Return on Assets (ROA)

The graph shows that the sample defense firms achieved average profitability throughout the period of study, as the sample median and industry norm ROAs were virtually the same. Although average firms within both the sample and the industry achieved steady returns of approximately 5-9%, the high variability and low to unprofitability among LQ firms is indicative of poor profitability within this line of business.

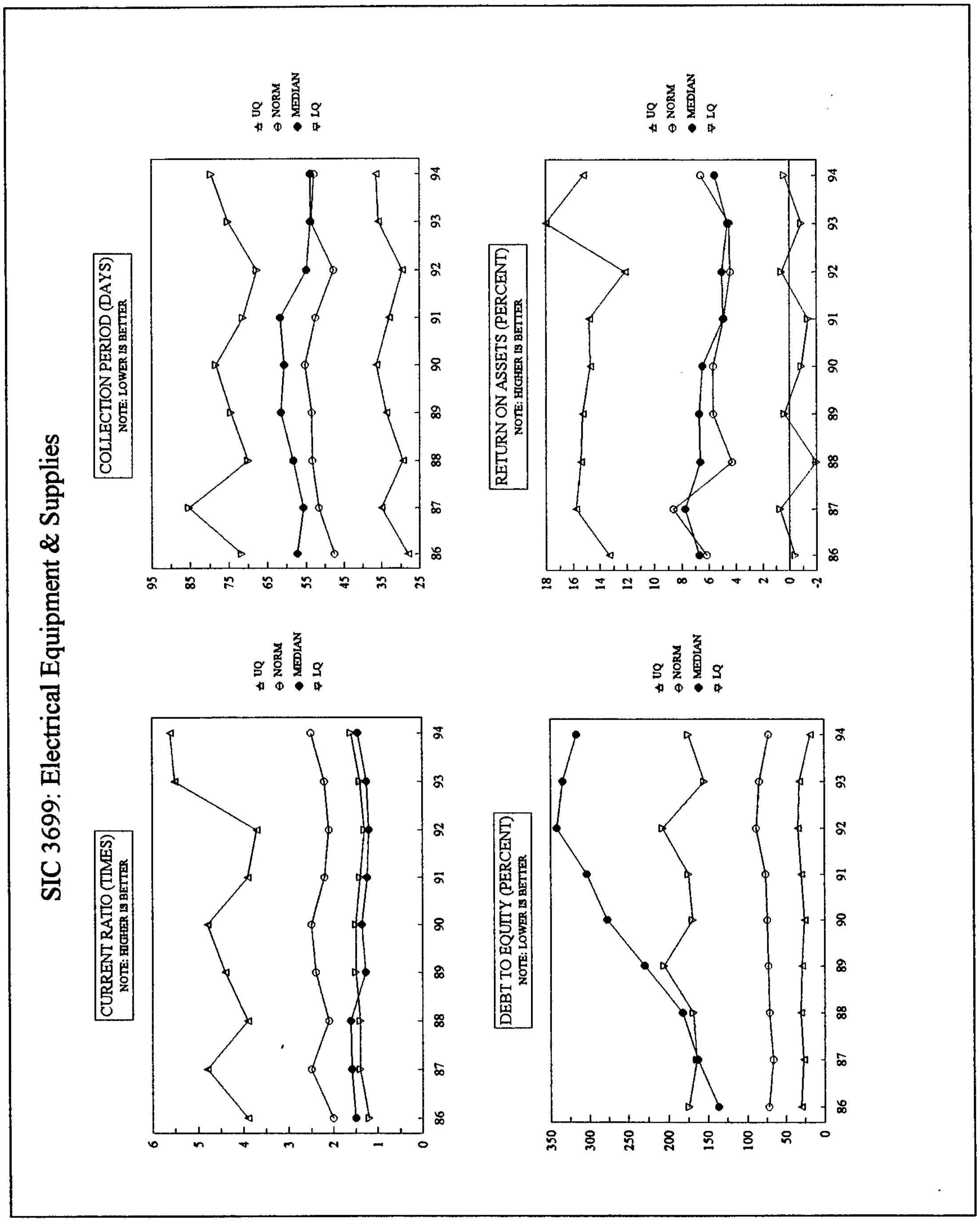

Figure 4-8. Graphical Analysis of SIC 3699: Electrical Equipment and Supplies.

9. SIC 3721: Aircraft

The greater degree of variability (i.e., fluctuation) among the ratios for companies within this SIC is due to the relatively smaller number of firms which operate in it.

a. Current Ratio (CR)

Figure 4-9 indicates below average solvency for the sample defense firms, as the CR curve approximately overlaps that of the LQ firms. The curves for the industry norm, UQ and LQ fluctuate too much to identify any industry-wide CR trend.

b. Debt to Equity (DE) Ratio

As with the CR, the graph again indicates below average solvency for the sample defense firms, as the DE ratio curve approximately overlaps that of the LQ firms. Except for '94, the industry DE ratio trends are relatively steady, indicative of fairly stable solvency conditions within the aircraft industry over the period of study. However, indicative of decreasing solvency, the CR for the LQ firms more than doubled in magnitude over the previous year.

c. Collection Period (CP)

While the CP trend for the sample firms was considerably more stable than the trends for the aircraft industry at large, the graph shows that the sample defense firms generally demonstrated below average efficiency at collecting receivables.

d. Return on Assets (ROA)

While the graph indicates that the sample defense firms achieved average to above average profitability over the duration of the drawdown, the relatively low values of the UQ firms is indicative of smaller ROAs within the aircraft industry, in general. However, when the LQ firms achieved ROAs, they were relatively higher than those achieved by firms in previously-evaluated SICs.

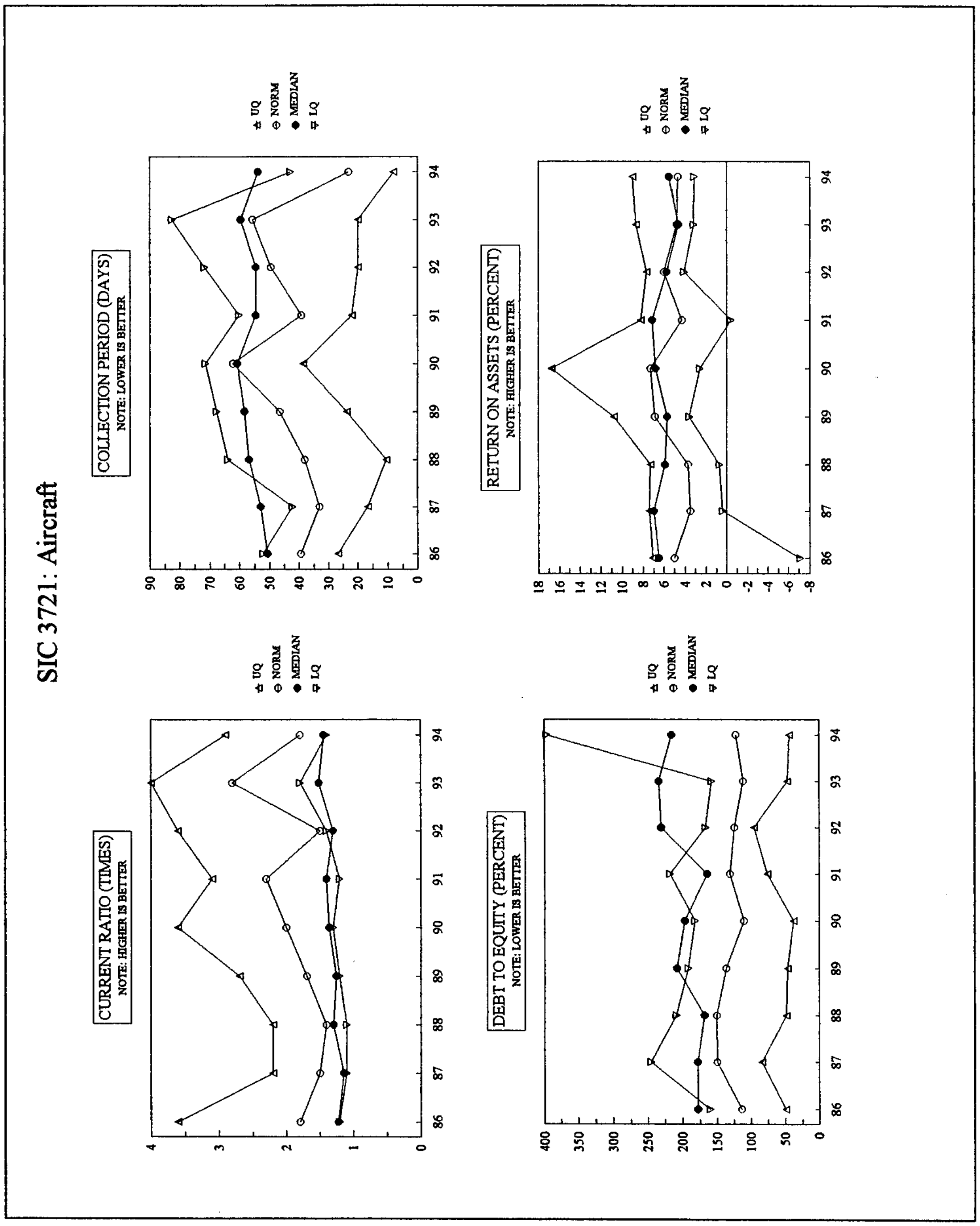

Figure 4-9. Graphical Analysis of SIC 3712: Aircraft.

10. SIC 3728: Aircraft Parts and Equipment, NEC

a. Current Ratio (CR)

Figure 4-10 shows that the sample defense firms operated in less solvent positions than three-quarters of all firms which operated within this line of business, as the sample median CRs were at or below the LQs throughout the study. The industry CR trends are all upward toward increasing solvency within the aircraft parts industry.

b. Debt to Equity (DE) Ratio

The graph indicates that, with regard to DE ratios, the sample defense firms operated at below average to extremely below average solvency levels over the period of study. While the industry DE ratio trends moved downward toward more solvent positions, the DE trend for the sample median climbed to a comparatively less solvent position.

c. Collection Period (CP)

Although the sample median CP values remained below (more efficient than) those of the LQ firms, the graph shows that the sample achieved below average efficiency for all but the first year of the study. As with the DE ratio, while the industry CP trends moved downward toward more efficient operating positions, the CP trend for the sample defense firms climbed to a comparatively less efficient position.

d. Return on Assets (ROA)

The graph shows that the sample defense firms achieved average profitability throughout the period of study, as the sample median and industry norm ROAs were virtually the same. However the industry ROA trends all moved downward toward less profitable positions, while the ROA trend for the sample defense firms remained relatively steady over this period.

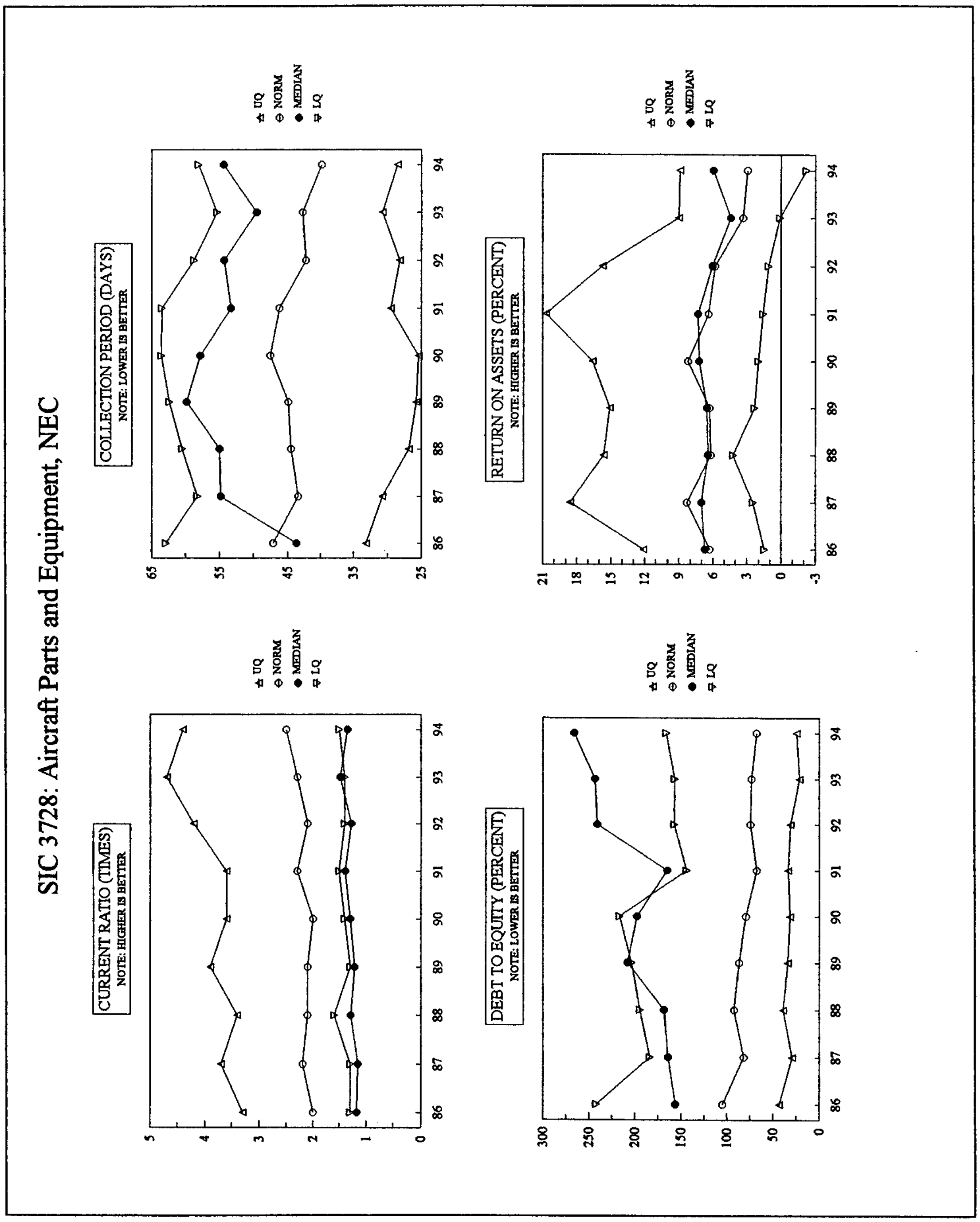

Figure 4-10. Graphical Analysis of SIC 3728: Aircraft Parts and Equipment, NEC.

11. SIC 3812: Search and Navigation Equipment

a. Current Ratio (CR)

Figure 4-11 shows that the sample defense firms operated in less solvent positions than three-quarters of all firms which operated within this line of business, as the sample median CRs were at or below the CRs of LQ firms throughout the study. While the sample median, industry norm and LQ CR trends were stable over time, the CR trend among UQ firms moved downward toward less solvent positions for these firms.

b. Debt to Equity (DE) Ratio

The graph indicates that, with regard to DE ratios, the sample defense firms operated at below average to extremely below average solvency levels over the period of study. The industry norm, UQ and LQ curves show increasing DE trends toward less solvent position. However, the magnitudes of these ratios support a solid position of solvency among industry participants in this SIC. The DE trend for the sample defense firms climbed steadily to decreasingly solvent positions.

c. Collection Period (CP)

The graph shows that the sample defense firms performed with average to slightly worse than average efficiency over the period of study. All of the CP curves indicate relatively stable efficiency over the period of study. However, the high LQ values show relatively inefficient operations among these LQ firms in that it takes them nearly three months to collect their receivables.

d. Return on Assets (ROA)

The graph shows that the sample defense firms achieved average to slightly above average profitability throughout the period of study. However the sample median ROA trend, as well as the industry ROA trends, all moved downward toward less profitable positions over the duration of the study.

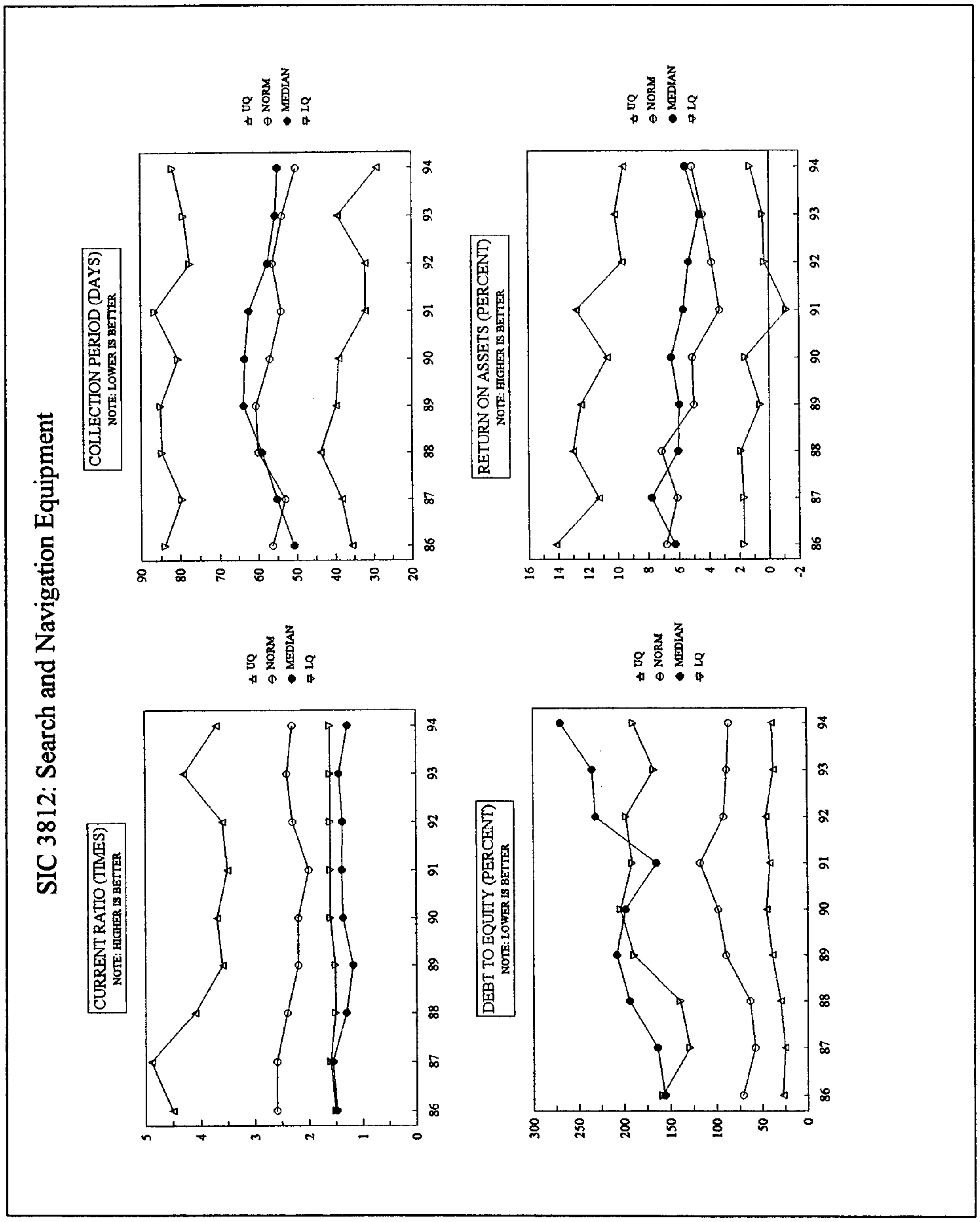

Figure 4-11. Graphical Analysis of SIC 3812: Search and Navigation Devices.

12. SIC 3829: Measuring and Controlling Devices, NEC

a. Current Ratio (CR)

Figure 4-12 shows that the sample defense firms operated in less solvent positions than three-quarters of all firms which operated within this line of business, as the sample median CRs were at or below the LQs throughout the study. The CR trends for the sample median, industry norm, and LQ were level, indicating steady solvency conditions. Except for the first year of the study, this was also true of the CR trend among UQ firms.

b. Debt to Equity (DE) Ratio

The graph indicates that, with regard to DE ratios, the sample defense firms operated at below average to extremely below average solvency levels over the period of study. The industry norm, UQ and LQ DE ratio curves remained level, indicative of firmly solvent conditions. Although the sample median DE ratio curve spiked upward in '88, its trend since then moved downward toward improved solvency.

c. Collection Period (CP)

Although the sample defense firms performed below average (i.e., worse than the industry norm) over most of the period of study, during the latter years of the study, median CP improved toward the industry average/norm. The industry CP trend moved downward toward a more efficient operating position.

d. Return on Assets (ROA)

The graph shows that the sample defense firms achieved average to below average profitability over the period of study. The high ROA values and upward trend among UQ firms, coupled with the fact that LQ firms achieved returns (although small) every year of the study, are factors indicative of improving profit conditions within this industry.

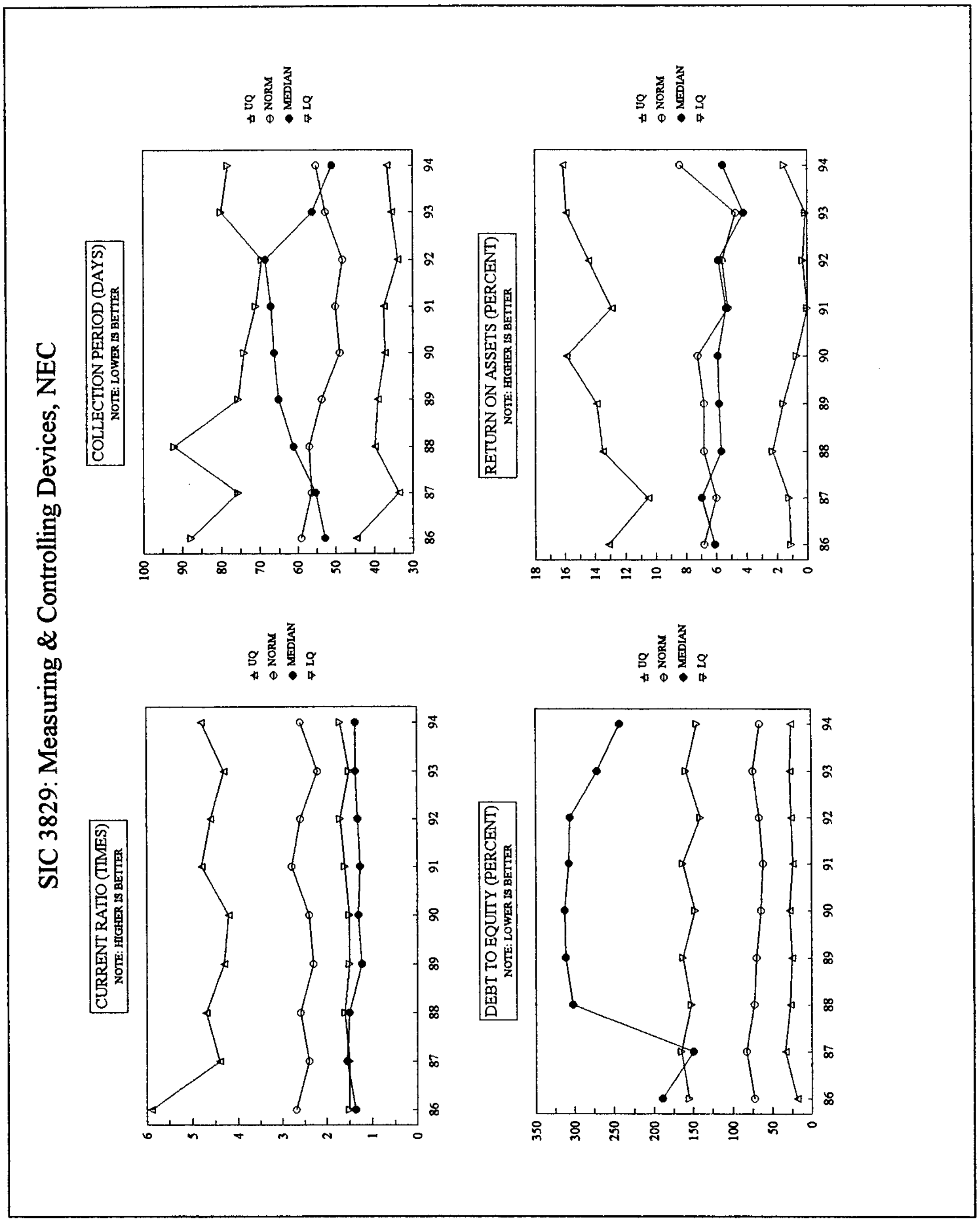

Figure 4-12. Graphical Analysis of SIC 3829: Measuring and Controlling Devices, NEC.

C. STATISTICAL ANALYSIS

The statistical analysis consisted of two types of hypothesis testing. First of all, a series of one-sample t-tests were conducted to determine whether the defense industry (as represented by the sample firms) was financially either better off, the same as, or worse off than all U.S. manufacturers within selected industry groups. During these tests, sample average ratio values were compared to established industry-wide averages/norms. Secondly, a series of two-sample t-tests were conducted in order to determine the effect of corporate strategic measures on the financial viability of defense firms during the defense drawdown. For these tests the firms were separated into two sample groups (defense-dependent and defense-indifferent, see Table 4-1) based on corporate strategies and degree of reliance (past, present and future) on defense business. Average financial ratio values for the two samples were compared to determine which group was financially better off over the period of the defense drawdown.

1. One-Sample Hypothesis Testing

The financial ratios used during these tests were: current ratio (CR), collection period (CP), and return on assets (ROA). These ratios are indicative of a firm's solvency, efficiency, and profitability respectively. The sample mean ratio values are compared with the industry ratio averages for the following five manufacturing industry sub-groups, as depicted by their two-digit SIC classification: Fabricated Metal Products (34); Industrial Machinery and Equipment (35); Electronics and Other Electric Equipment (36); Transportation Equipment (37); and Instruments and Related Products (38). A separate t-test was conducted for each ratio, for each two-digit SIC, for the years '93 and '94. Table 4-2 below shows the industry averages/norms used during these test. The source of these data was D&B's *Industry Norms & Key Business Ratios*.

Ratio	SIC 34 1993	SIC 34 1994	SIC 35 1993	SIC 35 1994	SIC 36 1993	SIC 36 1994	SIC 37 1993	SIC 37 1994	SIC 38 1993	SIC 38 1994
CR	2.1	2.1	2	2	2.3	2.3	2	2	2.4	2.6
CP	45.6	46.4	43.8	44.2	49.3	50	35.6	35.4	54	54
ROA	6.2	6.1	5.8	5.7	5.5	7.1	4.2	5.3	6.4	6.4

Table 4-2. Industry Norms for Selected Manufacturing Groups.

a. Current Ratio (CR)

- $H_0 : \overline{X}_{34,93} \geq \mu_{34,93}$ vs. $H_1 : \overline{X}_{34,93} < \mu_{34,93}; t = \frac{1.46616-2.1}{\frac{0.74976}{\sqrt{28}}} = -4.47; -t_{.05,27} = -1.703.$

  Since $t = -4.47 \leq -1.703 = -t_{.05,27}$; reject H_0; the sample defense firms were worse off (i.e., less solvent) than the average of all U.S. manufacturing firms operating within this SIC during 1993.

- $H_0 : \overline{X}_{34,94} \geq \mu_{34,94}$ vs. $H_1 : \overline{X}_{34,94} < \mu_{34,94}$; $t = \frac{1.497-2.1}{\frac{0.70725}{\sqrt{28}}} = -4.51 \leq -1.703.$

  Therefore, reject H_0; the sample defense firms were worse off (i.e., less solvent) than the average of all U.S. manufacturing firms operating within this SIC during 1994.

- $H_0 : \overline{X}_{35,93} \geq \mu_{35,93}$ vs. $H_1 : \overline{X}_{35,93} < \mu_{35,93}$; $t = \frac{1.46616-2.0}{\frac{0.74976}{\sqrt{28}}} = -3.77 \leq -1.703.$

  Therefore, reject H_0; the sample defense firms were worse off (i.e., less solvent) than the average of all U.S. manufacturing firms operating within this SIC during 1993.

- $H_0 : \overline{X}_{35,94} \geq \mu_{35,94}$ vs. $H_1 : \overline{X}_{35,94} < \mu_{35,94}$; $t = \frac{1.497-2.0}{\frac{0.70725}{\sqrt{28}}} = -3.76 \leq -1.703.$

  Therefore, reject H_0; the sample defense firms were worse off (i.e., less solvent) than the average of all U.S. manufacturing firms operating within this SIC during 1994.

- $H_0 : \overline{X}_{36,93} \geq \mu_{36,93}$ vs. $H_1 : \overline{X}_{36,93} < \mu_{36,93}$; $t = \frac{1.46616-2.3}{\frac{0.74976}{\sqrt{28}}} = -5.88 \leq -1.703.$

  Therefore, reject H_0; the sample defense firms were worse off (i.e., less solvent) than the average of all U.S. manufacturing firms operating within this SIC during 1993.

- $H_0 : \overline{X}_{36,94} \geq \mu_{36,94}$ vs. $H_1 : \overline{X}_{36,94} < \mu_{36,94}$; $t = \frac{1.497-2.3}{\frac{0.70725}{\sqrt{28}}} = -6.01 \leq -1.703.$

  Therefore, reject H_0; the sample defense firms were worse off (i.e., less solvent) than the average of all U.S. manufacturing firms operating within this SIC during 1994.

- $H_0 : \overline{X}_{37,93} \geq \mu_{37,93}$ vs. $H_1 : \overline{X}_{37,93} < \mu_{37,93}$; $t = \frac{1.46616-2.0}{\frac{0.74976}{\sqrt{28}}} = -3.77 \leq -1.703$.

  Therefore, reject H_0; the sample defense firms were worse off (i.e., less solvent) than the average of all U.S. manufacturing firms operating within this SIC during 1993.

- $H_0 : \overline{X}_{37,94} \geq \mu_{37,94}$ vs. $H_1 : \overline{X}_{37,94} < \mu_{37,94}$; $t = \frac{1.497-2.0}{\frac{0.70725}{\sqrt{28}}} = -3.76 \leq -1.703$.

  Therefore, reject H_0; the sample defense firms were worse off (i.e., less solvent) than the average of all U.S. manufacturing firms operating within this SIC during 1994.

- $H_0 : \overline{X}_{38,93} \geq \mu_{38,93}$ vs. $H_1 : \overline{X}_{38,93} < \mu_{38,93}$; $t = \frac{1.46616-2.4}{\frac{0.74976}{\sqrt{28}}} = -6.59 \leq -1.703$.

  Therefore, reject H_0; the sample defense firms were worse off (i.e., less solvent) than the average of all U.S. manufacturing firms operating within this SIC during 1993.

- $H_0 : \overline{X}_{38,94} \geq \mu_{38,94}$ vs. $H_1 : \overline{X}_{38,94} < \mu_{38,94}$; $t = \frac{1.497-2.6}{\frac{0.70725}{\sqrt{28}}} = -8.25 \leq -1.703$.

  Therefore, reject H_0; the sample defense firms were worse off (i.e., less solvent) than the average of all U.S. manufacturing firms operating within this SIC during 1994.

b. Collection Period (CP)

- $H_0 : \overline{X}_{34,93} \leq \mu_{34,93}$ vs. $H_1 : \overline{X}_{34,93} > \mu_{34,93}$; $t = \frac{55.066-45.6}{\frac{20.44527}{\sqrt{28}}} = 2.45 \geq t_{.05,27} = 1.703$.

  Since 2.45>1.703, reject H_0; the sample defense firms were worse off (i.e., less efficient) than the average of all U.S. manufacturing firms operating within this SIC during 1993.

- $H_0 : \overline{X}_{34,94} \leq \mu_{34,94}$ vs. $H_1 : \overline{X}_{34,94} > \mu_{34,94}$; $t = \frac{52.86-46.4}{\frac{19.62305}{\sqrt{28}}} = 1.74 \geq 1.703$.

  Therefore, reject H_0; the sample defense firms were worse off (i.e., less efficient) than the average of all U.S. manufacturing firms operating within this SIC during 1993.

- $H_0 : \overline{X}_{35,93} \leq \mu_{35,93}$ vs. $H_1 : \overline{X}_{35,93} > \mu_{35,93}$; $t = \frac{55.066-43.8}{\frac{20.44527}{\sqrt{28}}} = 2.92 \geq 1.703$.

  Therefore, reject H_0; the sample defense firms were worse off (i.e., less efficient) than the average of all U.S. manufacturing firms operating within this SIC during 1993.

- $H_0 : \overline{X}_{35,94} \leq \mu_{35,94}$ vs. $H_1 : \overline{X}_{35,94} > \mu_{35,94}$; $t = \frac{52.86-44.2}{\frac{19.62305}{\sqrt{28}}} = 2.34 \geq 1.703$.

  Therefore, reject H_0; the sample defense firms were worse off (i.e., less efficient) than the average of all U.S. manufacturing firms operating within this SIC during 1994.

- $H_0 : \overline{X}_{36,93} \leq \mu_{36,93}$ vs. $H_1 : \overline{X}_{36,93} > \mu_{36,93}$; $t = \frac{55.066-49.3}{\frac{20.44527}{\sqrt{28}}} = 1.49 < 1.703$.

  Therefore, do not reject H_0; the sample defense firms were no less well off (i.e., no less efficient) than the rest of the U.S. manufacturing firms operating within this SIC during 1993.

- $H_0 : \overline{X}_{36,94} \leq \mu_{36,94}$ vs. $H_1 : \overline{X}_{36,94} > \mu_{36,94}$; $t = \frac{52.86-50}{\frac{19.62305}{\sqrt{28}}} = 0.77 < 1.703$.

  Therefore, do not reject H_0; the sample defense firms were no less well off (i.e., no less efficient) than the rest of the U.S. manufacturing firms operating within this SIC during 1994.

- $H_0 : \overline{X}_{37,93} \leq \mu_{37,93}$ vs. $H_1 : \overline{X}_{37,93} > \mu_{37,93}$; $t = \frac{55.066-35.6}{\frac{20.44527}{\sqrt{28}}} = 5.04 \geq 1.703$.

  Therefore, reject H_0; the sample defense firms were worse off (i.e., less efficient) than the average of all U.S. manufacturing firms operating within this SIC during 1993.

- $H_0 : \overline{X}_{37,94} \leq \mu_{37,94}$ vs. $H_1 : \overline{X}_{37,94} > \mu_{37,94}$; $t = \frac{52.86-35.4}{\frac{19.62305}{\sqrt{28}}} = 4.71 \geq 1.703$.

  Therefore, reject H_0; the sample defense firms were worse off (i.e., less efficient) than the average of all U.S. manufacturing firms operating within this SIC during 1994.

- $H_0 : \overline{X}_{38,93} \leq \mu_{38,93}$ vs. $H_1 : \overline{X}_{38,93} > \mu_{38,93}$; $t = \frac{55.066-54}{\frac{20.44527}{\sqrt{28}}} = 0.28 < 1.703$.

  Therefore, do not reject H_0; the sample defense firms were no less well off (i.e., no less efficient) than the rest of the U.S. manufacturing firms operating within this SIC during 1993.

- $H_0 : \overline{X}_{38,94} \leq \mu_{38,94}$ vs. $H_1 : \overline{X}_{38,94} > \mu_{38,94}$; $t = \frac{52.86-54}{\frac{19.62305}{\sqrt{28}}} = -0.31 < 1.703$.

  Therefore, do not reject H_0; the sample defense firms were no less well off (i.e., no less efficient) than the rest of the U.S. manufacturing firms operating within this SIC during 1994.

c. Return on Assets (ROA)

- $H_0 : \overline{X}_{34,93} \geq \mu_{34,93}$ vs. $H_1 : \overline{X}_{34,93} < \mu_{34,93}$; $t = \frac{5.265-6.2}{\frac{2.826}{\sqrt{28}}} = -1.75 \leq -t_{.05,27} = -1.703.$

  Therefore, reject H_0; the sample defense firms were worse off (i.e., less profitable) than the average of all U.S. manufacturing firms operating within this SIC during 1993.

- $H_0 : \overline{X}_{34,94} \geq \mu_{34,94}$ vs. $H_1 : \overline{X}_{34,94} < \mu_{34,94}$; $t = \frac{5.66445-6.1}{\frac{2.65417}{\sqrt{28}}} = -0.87 > -1.703.$

  Therefore, do not reject H_0; the sample defense firms were no less well off (i.e., no less profitable) than the average of all U.S. manufacturing firms operating within this SIC during 1994.

- $H_0 : \overline{X}_{35,93} \geq \mu_{35,93}$ vs. $H_1 : \overline{X}_{35,93} < \mu_{35,93}$; $t = \frac{5.265-5.8}{\frac{2.826}{\sqrt{28}}} = -1.00 > -1.703.$

  Therefore, do not reject H_0; the sample defense firms were no less well off (i.e., no less profitable) than the average of all U.S. manufacturing firms operating within this SIC during 1993.

- $H_0 : \overline{X}_{35,94} \geq \mu_{35,94}$ vs. $H_1 : \overline{X}_{35,94} < \mu_{35,94}$; $t = \frac{5.66445-5.7}{\frac{2.65417}{\sqrt{28}}} = -0.07 > -1.703.$

  Therefore, do not reject H_0; the sample defense firms were no less well off (i.e., no less profitable) than the average of all U.S. manufacturing firms operating within this SIC during 1994.

- $H_0 : \overline{X}_{36,93} \geq \mu_{36,93}$ vs. $H_1 : \overline{X}_{36,93} < \mu_{36,93}$; $t = \frac{5.265-5.5}{\frac{2.826}{\sqrt{28}}} = -0.44 > -1.703.$

  Therefore, do not reject H_0; the sample defense firms were no less well off (i.e., no less profitable) than the average of all U.S. manufacturing firms operating within this SIC during 1993.

- $H_0 : \overline{X}_{36,94} \geq \mu_{36,94}$ vs. $H_1 : \overline{X}_{36,94} < \mu_{36,94}$; $t = \frac{5.66445-7.1}{\frac{2.65417}{\sqrt{28}}} = -2.86 \leq -1.703.$

  Therefore, reject H_0; the sample defense firms were worse off (i.e., less profitable) than the average of all U.S. manufacturing firms operating within this SIC during 1994.

- $H_0 : \overline{X}_{37,93} \geq \mu_{37,93}$ vs. $H_1 : \overline{X}_{37,93} < \mu_{37,93}$; $t = \frac{5.265-4.2}{\frac{2.826}{\sqrt{28}}} = 1.99 > -1.703.$

  Therefore, do not reject H_0; the sample defense firms were no less well off (i.e., no less profitable) than the average of all U.S. manufacturing firms operating within this SIC during 1993.

- $H_0 : \overline{X}_{37,94} \geq \mu_{37,94}$ vs. $H_1 : \overline{X}_{37,94} < \mu_{37,94}$; $t = \frac{5.66445-5.3}{\frac{2.65417}{\sqrt{28}}} = 0.73 > -1.703$.

  Therefore, do not reject H_0; the sample defense firms were no less well off (i.e., no less profitable) than the average of all U.S. manufacturing firms operating within this SIC during 1994.

- $H_0 : \overline{X}_{38,93} \geq \mu_{38,93}$ vs. $H_1 : \overline{X}_{38,93} < \mu_{38,93}$; $t = \frac{5.265-6.4}{\frac{2.826}{\sqrt{28}}} = -2.13 \leq -1.703$.

  Therefore, reject H_0; the sample defense firms were worse off (i.e., less profitable) than the average of all U.S. manufacturing firms operating within this SIC during 1993.

- $H_0 : \overline{X}_{38,94} \geq \mu_{38,94}$ vs. $H_1 : \overline{X}_{38,94} < \mu_{38,94}$; $t = \frac{5.66445-6.4}{\frac{2.65417}{\sqrt{28}}} = -1.47 > -1.703$.

  Therefore, do not reject H_0; the sample defense firms were no less well off (i.e., no less profitable) than the average of all U.S. manufacturing firms operating within this SIC during 1994.

d. Summary One-Sample t-test Results

Table 4-3 summarizes the one-sample t-test results. The null hypotheses for all of the ratios were that the defense industry (as represented by the sample firms) was as well off, or better off financially (i.e., at least as well off) as the average of all U.S. manufacturers within the five major manufacturing sub-groups. The *reject* outcome in the table below means that the defense industry was either less solvent (lower CR values), less efficient (higher CP values), or less profitable (lower ROA values) than the average U.S. manufacturer. The *do not reject* outcome in the table means that the data support the null hypothesis -- the defense industry was at least as financially well off (i.e., equally or more solvent, efficient, or profitable) as the average U.S. manufacturing firms.

Ratio	SIC 34 1993	SIC 34 1994	SIC 35 1993	SIC 35 1994	SIC 36 1993	SIC 36 1994	SIC 37 1993	SIC 37 1994	SIC 38 1993	SIC 38 1994
CR	reject	reject	reject	reject	reject	reject	reject	reject	reject	reject
CP	reject	reject	reject	reject	do not reject	do not reject	reject	reject	do not reject	do not reject
ROA	reject	do not reject	do not reject	do not reject	do not reject	reject	do not reject	do not reject	reject	do not reject

Table 4-3. Summary One-Sample t-test Results.

2. Two-Sample Hypothesis Testing

The financial ratios used during these tests were: the current ratio (CR), inventory turnover (ITO), and gross margin ratio (GMR). These ratios are indicative of a firm's solvency, efficiency, and profitability respectively. Based on the sample segregation by level of participation in the defense industry (see Table 4-1), the sample ratio means of the defense-dependent firms ($\overline{X}$ in the formulae below) were compared with those of the defense-indifferent firms ($\overline{Y}$ in the formulae below) to determine which firms were financially better off (i.e., more solvent, efficient and profitable) during the defense drawdown. A separate t-test was conducted for each of the three ratios, for every year of the study. Unlike the one-sample t-tests, where the t statistics were manually calculated from the descriptive statistics, these and the comparison t values were computed by Quatttro Pro computer software.

a. Current Ratio (CR)

- $H_0 : \overline{X}_{86} \geq \overline{Y}_{86}$ vs. $H_1 : \overline{X}_{86} < \overline{Y}_{86}$; $t = 0.876 > -1.746 = -t_{\alpha,\gamma}$.
  Therefore, do not reject H_0; the defense-dependent firms were better off (i.e., more solvent) than the defense-indifferent firms during 1986.

- $H_0 : \overline{X}_{87} \geq \overline{Y}_{87}$ vs. $H_1 : \overline{X}_{87} < \overline{Y}_{87}$; $t = 0.585 > -1.734$.
  Therefore, do not reject H_0; the defense-dependent firms were better off (i.e., more solvent) than the defense-indifferent firms during 1987.

- $H_0 : \overline{X}_{88} \geq \overline{Y}_{88}$ vs. $H_1 : \overline{X}_{88} < \overline{Y}_{88}$; $t = 1.606 > -1.725$.
  Therefore, do not reject H_0; the defense-dependent firms were better off (i.e., more solvent) than the defense-indifferent firms during 1988.

- $H_0 : \overline{X}_{89} \geq \overline{Y}_{89}$ vs. $H_1 : \overline{X}_{89} < \overline{Y}_{89}$; $t = 1.88 > -1.73$.
  Therefore, do not reject H_0; the defense-dependent firms were better off (i.e., more solvent) than the defense-indifferent firms during 1989.

- $H_0 : \overline{X}_{90} \geq \overline{Y}_{90}$ vs. $H_1 : \overline{X}_{90} < \overline{Y}_{90}$; $t = 2.307 > -1.74$.
  Therefore, do not reject H_0; the defense-dependent firms were better off (i.e., more solvent) than the defense-indifferent firms during 1990.

- $H_0 : \overline{X}_{91} \geq \overline{Y}_{91}$ vs. $H_1 : \overline{X}_{91} < \overline{Y}_{91}$; $t = 2.796 > -1.746$.
  Therefore, do not reject H_0; the defense-dependent firms were better off (i.e., more solvent) than the defense-indifferent firms during 1991.

- $H_0 : \overline{X}_{92} \geq \overline{Y}_{92}$ vs. $H_1 : \overline{X}_{92} < \overline{Y}_{92}$; $t = 2.808 > -1.708$.
  Therefore, do not reject H_0; the defense-dependent firms were better off (i.e., more solvent) than the defense-indifferent firms during 1992.

- $H_0 : \overline{X}_{93} \geq \overline{Y}_{93}$ vs. $H_1 : \overline{X}_{93} < \overline{Y}_{93}$; $t = 2.77 > -1.74$.
  Therefore, do not reject H_0; the defense-dependent firms were better off (i.e., more solvent) than the defense-indifferent firms during 1993.

- $H_0 : \overline{X}_{94} \geq \overline{Y}_{94}$ vs. $H_1 : \overline{X}_{94} < \overline{Y}_{94}$; $t = 2.18 > -1.721$.
  Therefore, do not reject H_0; the defense-dependent firms were better off (i.e., more solvent) than the defense-indifferent firms during 1994.

b. Inventory Turnover (ITO) Ratio

- $H_0 : \overline{X}_{86} \geq \overline{Y}_{86}$ vs. $H_1 : \overline{X}_{86} < \overline{Y}_{86}$; $t = 0.9036 > -1.72 = -t_{\alpha,\gamma}$.
  Therefore, do not reject H_0; the defense-dependent firms were better off (i.e., more efficient) than the defense-indifferent firms during 1986.

- $H_0 : \overline{X}_{87} \geq \overline{Y}_{87}$ vs. $H_1 : \overline{X}_{87} < \overline{Y}_{87}$; $t = 0.64 > -1.72$.
  Therefore, do not reject H_0; the defense-dependent firms were better off (i.e., more efficient) than the defense-indifferent firms during 1987.

- $H_0 : \overline{X}_{88} \geq \overline{Y}_{88}$ vs. $H_1 : \overline{X}_{88} < \overline{Y}_{88}$; $t = -0.06 > -1.708$.
  Therefore, do not reject H_0; the defense-dependent firms were better off (i.e., more efficient) than the defense-indifferent firms during 1988.

- $H_0 : \overline{X}_{89} \geq \overline{Y}_{89}$ vs. $H_1 : \overline{X}_{89} < \overline{Y}_{89}$; $t = -0.2845 > -1.708$.
  Therefore, do not reject H_0; the defense-dependent firms were better off (i.e., more efficient) than the defense-indifferent firms during 1989.

- $H_0 : \overline{X}_{90} \geq \overline{Y}_{90}$ vs. $H_1 : \overline{X}_{90} < \overline{Y}_{90}$; $t = 0.067 > -1.72$.
  Therefore, do not reject H_0; the defense-dependent firms were better off (i.e., more efficient) than the defense-indifferent firms during 1990.

- $H_0 : \overline{X}_{91} \geq \overline{Y}_{91}$ vs. $H_1 : \overline{X}_{91} < \overline{Y}_{91}$; $t = 0.322 > -1.725$.
  Therefore, do not reject H_0; the defense-dependent firms were better off (i.e., more efficient) than the defense-indifferent firms during 1991.

- $H_0 : \overline{X}_{92} \geq \overline{Y}_{92}$ vs. $H_1 : \overline{X}_{92} < \overline{Y}_{92}$; $t = 0.336 > -1.734$.
  Therefore, do not reject H_0; the defense-dependent firms were better off (i.e., more efficient) than the defense-indifferent firms during 1992.

- $H_0 : \overline{X}_{93} \geq \overline{Y}_{93}$ vs. $H_1 : \overline{X}_{93} < \overline{Y}_{93}$; $t = 0.505 > -1.725$.
  Therefore, do not reject H_0; the defense-dependent firms were better off (i.e., more efficient) than the defense-indifferent firms during 1993.

- $H_0 : \overline{X}_{94} \geq \overline{Y}_{94}$ vs. $H_1 : \overline{X}_{94} < \overline{Y}_{94}$; $t = -0.77 > -1.708$.
  Therefore, do not reject H_0; the defense-dependent firms were better off (i.e., more efficient) than the defense-indifferent firms during 1994.

*c. **Gross Margin Ratio (GMR)***

- $H_0 : \overline{X}_{86} \geq \overline{Y}_{86}$ vs. $H_1 : \overline{X}_{86} < \overline{Y}_{86}$; $t = -1.04 > -1.72 = t_{\alpha,\gamma}$.
  Therefore, do not reject H_0; the defense-dependent firms were better off (i.e., more profitable) than the defense-indifferent firms during 1986.

- $H_0 : \overline{X}_{87} \geq \overline{Y}_{87}$ vs. $H_1 : \overline{X}_{87} < \overline{Y}_{87}$; $t = -1.952 \leq -1.708$.
  Therefore, reject H_0; the defense-dependent firms were worse off (i.e., less profitable) than the defense-indifferent firms during 1987.

- $H_0 : \overline{X}_{88} \geq \overline{Y}_{88}$ vs. $H_1 : \overline{X}_{88} < \overline{Y}_{88}$; $t = -1.806 \leq -1.708$.
  Therefore, reject H_0; the defense-dependent firms were worse off (i.e., less profitable) than the defense-indifferent firms during 1988.

- $H_0 : \overline{X}_{89} \geq \overline{Y}_{89}$ vs. $H_1 : \overline{X}_{89} < \overline{Y}_{89}$; $t = -2.08 \leq -1.71$.
  Therefore, reject H_0; the defense-dependent firms were worse off (i.e., less profitable) than the defense-indifferent firms during 1989.

- $H_0 : \overline{X}_{90} \geq \overline{Y}_{90}$ vs. $H_1 : \overline{X}_{90} < \overline{Y}_{90}$; $t = -2.18 \leq -1.708$.
  Therefore, reject H_0; the defense-dependent firms were worse off (i.e., less profitable) than the defense-indifferent firms during 1990.

- $H_0 : \overline{X}_{91} \geq \overline{Y}_{91}$ vs. $H_1 : \overline{X}_{91} < \overline{Y}_{91}$; $t = -1.54 > -1.714$.
  Therefore, do not reject H_0; the defense-dependent firms were better off (i.e., more profitable) than the defense-indifferent firms during 1991.

- $H_0 : \overline{X}_{92} \geq \overline{Y}_{92}$ vs. $H_1 : \overline{X}_{92} < \overline{Y}_{92}$; $t = -1.82 \leq -1.717$.
  Therefore, reject H_0; the defense-dependent firms were worse off (i.e., less profitable) than the defense-indifferent firms during 1992.

- $H_0 : \overline{X}_{93} \geq \overline{Y}_{93}$ vs. $H_1 : \overline{X}_{93} < \overline{Y}_{93}$; $t = -2.34 \leq -1.708$.
  Therefore, reject H_0; the defense-dependent firms were worse off (i.e., less profitable) than the defense-indifferent firms during 1993.

- $H_0 : \overline{X}_{94} \geq \overline{Y}_{94}$ vs. $H_1 : \overline{X}_{94} < \overline{Y}_{94}$; $t = -2.196 \leq -1.71$.
  Therefore, reject H_0; the defense-dependent firms were worse off (i.e., less profitable) than the defense-indifferent firms during 1994.

d. Summary Two-Sample t-test Results

Table 4-4 summarizes the t-test results. The null hypotheses for all of the ratios were that the more defense-dependent sample firms were equally well off, or better off financially (i.e., at least as well off) than the more defense-indifferent sample firms over the period of the drawdown. The *reject* outcome in the table below means that the defense-dependent firms were either less solvent (lower CR values), less efficient (lower ITO values), or less profitable (lower GMR values) than the defense-indifferent firms in the given year. The *do not reject* outcome in the table means that the data support the null hypothesis -- the defense-dependent firms were at least as financially well off (i.e., equally or more solvent, efficient, or profitable) as the defense-indifferent firms.

Ratio	1986	1987	1988	1989	1990	1991	1992	1993	1994
CR	do not reject	do not reject	do not reject	do not reject	do not reject	do not reject	do not reject	do not reject	do not reject
ITO	do not reject	do not reject	do not reject	do not reject	do not reject	do not reject	do not reject	do not reject	do not reject
GMR	do not reject	reject	reject	reject	reject	do not reject	reject	reject	reject

Table 4-4. Summary Two-Sample t-test Results.

V. CONCLUSIONS AND RECOMMENDATIONS

A. SUMMARY

The purpose of this thesis was to determine if, in light of the post Cold War drawdown, all of the concern over the survival of the U.S. defense industrial base was warranted. Using financial ratios as measures of performance, this thesis attempted to measure the effect of the defense drawdown on the financial viability of defense firms. Defense industry financial viability was analyzed in terms of three aspects: solvency, efficiency, and profitability. This financial analysis employed graphical and statistical techniques to: (1) identify trends over the period of the defense drawdown; (2) measure defense industry performance (as represented by the sample firms) compared to U.S. manufacturing industry averages over this same period; and (3) identify the relationship between defense firm strategic commitment to/dependence on defense business and the financial viability of these firms over the period of the drawdown. Although the section below gives a more detailed report of the results of this thesis, the following broad conclusions were reached regarding the three aspects of financial viability investigated therein. The trends for solvency, efficiency, and profitability are mixed, with the ratios within each indicator group often contradicting each other. Regarding defense industry performance relative to the U.S. manufacturing industry as a whole, the defense firms generally were less solvent, less efficient, and more profitable. However, the more defense-dependent firms were generally more solvent, more efficient, and less profitable than the firms whose strategies and business bases indicated indifference toward defense business. In summary, while the findings of this thesis give cause for alarm, it appears that the firms of the U.S. defense industrial base are adopting strategies to adapt to their changing financial conditions brought about by the post Cold War defense drawdown.

B. CONCLUSIONS

1. Defense Contractor Strategies

This thesis reported some of the various strategies undertaken by defense firms to survive and compete in the post Cold War era. These strategies ranged from the general classifications defined by Government agencies familiar with the defense industry, to the specific strategies declared by particular defense firms. While many of these strategies were given different labels by Government and industry, and neither party described a complete list of available strategies, one principle is clear. All of the various corporate strategies undertaken by defense firms are defined relative to the makeup of the firms' business bases (i.e., the amounts of defense/Government business versus commercial work). This thesis concludes that all corporate defense strategies are subordinate to one of two possible overarching strategies -- defense-dependence and defense-indifference.

An interesting observation was that many of the sample defense firms which operate in the communications and electronics business sectors are optimistic about the defense drawdown, because the DoD's reduction in the number of new start programs, in favor of less expensive upgrades to existing systems, favors the particular technical expertise of such firms. This niche in the defense market has and will continue to allow defense firms to more gradually transition toward commercial markets. Another important point to mention regarding the defense-indifferent strategy of commercialization is that many of the major defense prime contractors remain leery of such endeavors. They cite past failures of similar efforts by their own firms and those of sister defense firms as reasons for avoiding this strategy.

An important defense-dependent strategy to note is that of acquisitions and mergers among defense firms. There is some concern that the recent rash of mergers (note: six of the sample firms in this thesis have merged into three firms) will reduce the level of price and technical competition for major defense systems. While this concern may be warranted, to evaluate these strategies only from the perspective of their effects on

competition overlooks the potential benefits afforded the DoD customer by such actions. By merging with former competitors, firms are able to bring to bear technical synergies and cost-reducing measures which were previously unachievable.

2. Solvency

Using current ratios (CR) and debt to equity (DE) ratios as performance measures, the effect of the drawdown on the solvency of the defense industry was analyzed. As a result of this analysis, this thesis makes several conclusions about defense firm solvency over the nine year period of study. The graphical presentation of the data in Chapter III indicates that the CR trends of 22 of the 28 sample defense firms were steady or increasing over the period of the drawdown, thereby indicating stable or improving solvency conditions over time. These graphs similarly indicate that the DE trends for a majority (17 of 28) of the firms were steady or decreasing over the period, therefore supporting the conclusion that the overall trend for solvency conditions was steady or improved over this period. However, the comparative analysis of Chapter IV shows a more bleak picture of defense industry solvency. Both graphical and statistical tests indicate that, in all cases, the solvency ratio averages of sample defense firms fell below the established industry averages. The resulting conclusion is that, compared to the U.S. manufacturing industry at large, the defense industry was considerably less solvent over the period of the defense drawdown. However, this conclusion is tempered by the results of the comparison between the defense-dependent and defense-indifferent firms. In all cases, these tests indicated that the more defense-dependent firms were more solvent than their defense-indifferent counterparts within the sample. This finding supports the conclusion that defense industry solvency improves with the degree of dependency on defense contracts.

3. Efficiency

Using working capital to total assets (WCTA), collection period (CP), and inventory turnover (ITO) ratios as performance measures, the effect of the drawdown on

the operating efficiency of the defense industry was analyzed. As a result of this analysis, this thesis makes several conclusions about defense firm efficiency over the nine year period of study. The graphical presentation of the data in Chapter III indicates that the WCTA trends of only 13 of the 28 sample defense firms were steady or increasing over the period of the drawdown, thereby indicating unstable or decreasingly efficient operating conditions (i.e., less working capital as a percent of total assets) for most of the sample defense firms over time. These graphs also indicate that the CP trends for a majority (16 of 28) of the firms were steady or decreasing over the period, evidence of increasingly efficient operations in terms of collection of receivables by most of the firms. The ITO trends, whereby 22 of 28 firms showed steady or increasing efficiency at turning over inventory, are indicative of stable to improving operating conditions within the defense industry over the period of study. The comparative analysis of Chapter IV supports these somewhat mixed conclusions regarding defense industry operating efficiency. Using CP as a measure of performance, the graphical analysis indicates that, in nearly all cases (10 of 12 SICs studied), sample defense firms performed below the industry averages for efficient collection of receivables. However, the statistical tests indicate that, using the same metric of CP, the sample defense firms operated at least as efficiently as all U.S. manufacturers within two of the five industry sub-groups studied (Electronics and Other Electric Equipment, and Instruments and Related Products). The resulting conclusion is that, compared to the U.S. manufacturing industry at large, the defense industry was somewhat less efficient at collecting receivables over the period of the defense drawdown. However, this outcome is less a result of management decisions, and more a necessary result of the slower, paper-laden defense procurement process, whereby items which are built to complex specifications must be thoroughly inspected before they are accepted. Using ITO as a metric, the results of the statistical comparison between the defense-dependent and defense-indifferent firms indicate that, in all cases, the more defense-dependent firms were more efficient at turning inventory into finished goods than their defense-indifferent counterparts within the sample. This finding supports the conclusion that defense industry

operating efficiency, at least in terms of inventory turnover, improves with the degree of dependency on defense contracts. This outcome can be explained by the fact that virtually all defense products are "made-to-order", not sold from inventory.

4. Profitability

Using the gross margin ratio (GMR), return on assets (ROA), and return on investment (ROI) ratios as performance measures, the effect of the drawdown on defense industry profitability was analyzed. As a result of this analysis, this thesis makes several conclusions about defense firm profitability over the nine year period of study. The graphical presentation of the data in Chapter III indicates that the ROA and ROI trends of less than half of the sample defense firms (12 of 28 and 13 of 28, respectively) were steady or increasing over the period of the drawdown, thereby indicating fairly unstable or decreasingly profitable conditions for most of the sample defense firms over time. However, these graphs also indicate that the GMR trends for a great majority (23 of 28) of the firms were steady or increasing over the period, evidence of stable to increasingly profitable conditions within the defense industry. The comparative analysis of Chapter IV supports these somewhat mixed conclusions regarding defense industry profitability during the drawdown. Using ROA as a measure of performance, the graphical analysis indicates that, in all cases, sample defense firms achieved either average or above average profitability compared to the industry averages for U.S. manufacturers operating within selected SICs. Similarly, the statistical tests, using the same metric of ROA, indicated that the sample defense firms operated at least as profitably as all U.S. manufacturers within three of five and four of the five industry sub-groups studied during '93 and '94 respectively. The resulting conclusion is that, compared to the U.S. manufacturing industry, at large, the defense industry was somewhat more profitable over the period of the defense drawdown. However, using GMR as a metric, the results of the statistical comparison between the defense-dependent and defense-indifferent firms indicate that, during seven of the nine years studied, the more defense-dependent firms were less profitable than their defense-indifferent counterparts within the sample. This finding

supports the conclusion that defense industry profitability, in terms of the GMR, tends to decrease with the degree of dependency on defense contracts.

C. RECOMMENDATIONS

Although not a part of the original purpose of this thesis, a number of recommendations have occurred to the author as a result of this research. While all of these recommendations may not be original (in fact, some are quite commonly accepted), they all originated from or were reinforced by this effort. Recommendations are addressed to the following three groups of readers of this thesis: Government officials, defense industry officials, and future researchers.

1. Recommendations to Government Officials

- Avoid the use of Firm-Fixed-Price contracts for defense R&D. Many of the firms in this study reported large write-offs associated with such contracts. Although defense acquisition management personnel both inside and outside Government recognize the importance of selecting a contract type according to the degrees of risk faced by both parties, the use and misuse of either cost-type or fixed-price contracts exclusively has been a cyclical occurrence over the past four decades.

- Recognize the role economic security plays in national security. These two aspects of American democracy are complementary and mutually supporting, such that one cannot exist without the other. However, DoD and service officials, as well as members of the Congress, must balance each of these tenets of a free society to prevent interference between them. Defense officials often complain of Congressional interference with defense program decisions. While Congress should recognize that it is the responsibility of the services and the Defense Department to determine defense system requirements based on mission needs, DoD officials should also take into account the economic and political impacts of these program decisions. While such recommendations are easy to make, they are quite difficult to implement.

- With an eye on the competitive effects of such moves, the DoD should continue to encourage and support mergers and acquisitions among defense firms when they offer potential for technical synergies, reductions of excess capacity, and reduced overhead costs associated with defense contracts. Instead of being alarmed by the recent acquisition and merger trends within the defense industry,

Government officials should see these reactions to declining defense budgets as necessary and beneficial measures taken by prudent business executives to secure returns to shareholders, and remain financially viable and competitive.

- Continue to reform the defense acquisition system by seeking defense industry input. The only thing that is constant about the defense acquisition system is reform. Such ongoing reform efforts as the use of commercial business practices and specifications, the use of electronic commerce measures, reduced Government oversight and audit, and the use of Integrated Process and Product Development Teams, if correctly implemented, will provide a huge leap forward toward fixing a system which all agree is broken.

- The current Government position of leaving the free market to decide the fate of the defense industry in the post Cold War era is, in this researcher's opinion, fundamentally sound, but requires continuous monitoring by Government agencies to ensure that sufficient capacity and technical capability exist to meet anticipated future needs. While the DoD should remain concerned over foreign sourcing of key defense materials, the isolationist views of certain advocates are counterproductive, since they reflect ignorance of the increasingly global nature of defense markets. The efforts of the Office of the Assistant Secretary of Defense for Economic Security, regarding the assessment of defense industrial capabilities, will facilitate the monitoring of key defense industrial base capabilities, while providing defense PMs tools to decide appropriate alternatives for the preservation of capabilities vital to national security.

2. Recommendations to Defense Industry Officials

- Continuously evaluate the impacts that corporate defense industry strategies have on the various aspects of corporate financial viability. Analytical approaches such as those used in this thesis, whereby financial conditions of defense-dependent firms were compared with those of defense-indifferent firms, provide useful insight into the relationship between financial viability and defense dependency.

- Defense corporations which decide, as a strategy to face the defense drawdown, on increasing their commercial business bases through acquisition of commercial business units should attempt to acquire enterprises which are related to particular defense business applications, expertise, or assets. However, if this is not possible and the defense firm acquires such a commercial firm solely for commercial business opportunities, the new acquisition should be operated as a subsidiary or at least a profit center if operated as a division of the parent defense firm.

3. Recommendations for Future Research

- Conduct a financial analysis comparing the financial conditions of defense firms before and after their mergers with former defense industry competitors. The mergers of the six sample firms within this thesis, along with a possible merger of Boeing and McDonnell Douglas, provide situations ripe for investigation.

- Conduct a financial analysis comparing a parent company (e.g., General Motors) with its primary subsidiary/division which produces defense products (e.g., GM Hughes Electronics).

- Conduct a financial analysis of selected defense firms using the procedures outlined by the DoD in *A DoD Handbook, Assessing Defense Industrial Capabilities* (Ref. 66).

- Using a methodology similar to that used in this thesis, conduct a financial analysis comparing the financial conditions of samples of defense-dependent, defense-indifferent, and *defense-independent* (i.e., strictly commercial) firms.

APPENDIX. SAMPLE SIC CODE CLASSIFICATIONS

SIC	SHORT TITLE	BOE	ESYS	GD	GM	LITT	LOCK	MM	LOR	McDD	NOR/GR	RAY	RWI	ITT	TEXT	UT	IBM	USYS	TENN	LTV	GTE	FMC	MOT	TI	HRS	GE	HONY	WEST
O781	Landscape Counseling and Planning														D													
1041	Gold Ores																					PS						
1044	Silver Ores																					PS						
1221	Bituminous Coal and Lignite-Surface			P																								
1411	Dimension Stone																					D						
1422	Crushed and Broken Limestone			P																S								
1442	Construction Sand and Gravel							PS																				
1446	Industrial Sand																					D						
1479	Chemical and Fertilizer Mining																					PD						
1541	Industrial Buildings and Warehouses											S																
1629	Heavy Construction, NEC											P										S						
1711	Plumbing, Heating, Air-Conditioning																										P	
1796	Installing Building Equipment, NEC															S												
2411	Logging													S														
2421	Sawmills and Planning Mills, General													S					S									
2521	Wood Office Furniture																											S
2531	Public Building & Related Furniture																											S
2611	Pulp Mills																		S									
2631	Paperboard Mills																		S									
2653	Corrugated and Solid Fiber Boxes																		S									
2678	Stationary Products																		S									
2679	Converted Paper Products, NEC																		S									
2731	Book Publishing											P																
2741	Miscellaneous Publishing																				PS							
2771	Greeting Cards														P													
2782	Blankbooks and Looseleaf Binders														P													
2819	Industrial Inorganic Chemicals, NEC															D						PD						
2836	Biological Products Excl. Diagnostics																					P						
2844	Toilet Preparations														P													
2869	Industrial Organic Chemicals, NEC															D						D						
2874	Phosphatic Fertilizer																					P						
2879	Agricultural Chemicals, NEC																					P						
2891	Adhesives and Sealants														P													
2899	Chemical Preparations, NEC															D			S									
2992	Lubricating Oils and Greases																		S									
3089	Plastics Products, NEC														PD				S							S		
3251	Brick and Structural Clay Tile			P																								
3255	Clay Refractories							PS																				
3272	Concrete Products, NEC			P																								
3273	Ready-Mix Concrete			P																								
3274	Lime			P				S																				
3295	Minerals, Ground or Treated							S														D						
3312	Blast Furnaces and Steel Mills				D															PS								
3316	Cold Finishing of Steel Shapes																			S								
3317	Steel Pipe and Tubes																			S						S		
3321	Gray and Ductile Iron Foundries				D										PD													
3322	Malleable Iron Foundries				D																							
3325	Steel Foundries, NEC														D							D						
3357	Nonferrous Wiredrawing and Insulating				DS																							
3365	Aluminum Foundries				D									S														
3369	Nonferrous Foundries, NEC								P																			
3398	Metal Heat Treating																											
3399	Primary Metal Products, NEC																							P				
3433	Heating Equipment, Except Electric											S		DS		S												
3441	Fabricated Structural Metal			P	S																							
3443	Fabricated Plate Work (Boiler Shops)											S														S		
3444	Sheet Metalwork											S																
3449	Miscellaneous Metal Work														D													
3451	Screw Machine Products														P													
3452	Bolts, Nuts, Rivets, and Washers														PD													
3462	Iron and Steel Forgings												D									PD						
3465	Automotive Stampings												PD		PD	D												
3469	Metal Stampings, NEC														D	D												
3483	Ammunition, Except for Small Arms, NEC							PS			P				D													
3489	Ordnance and Accessories, NEC				S										D							P						D
3491	Industrial Valves													DS													PD	
3492	Fluid Power Valves & Hose Fittings																										PD	
3493	Steel Springs, Except Wire												PD															
3496	Misc. Fabricated Wire Products			D											P													
3498	Fabricated Pipe and Fittings													D												S		

SIC	SHORT TITLE	BOE	ESYS	GD	GM	LITT	LOCK	MM	LOR	McDD	NOR/GR	RAY	RWI	ITT	TEXT	UT	IBM	USYS	TENN	LTV	GTE	FMC	MOT	TI	HRS	GE	HONY	WEST
3499	Fabricated Metal Products, NEC																		S									
3511	Turbines and Turbine Generator Sets				P										PS	P										PS		S
3519	Internal Combustion Engines, NEC				PD										P	P												
3523	Farm Machinery and Equipment											S							S			P						
3524	Lawn and Garden Equipment														P													
3531	Construction Machinery											PS							S									
3532	Mining Machinery											S														S		
3533	Oil and Gas Field Machinery																			S		P						
3534	Elevators and Moving Stairways															PS												S
3535	Conveyors and Conveying Equipment											S										P				S		
3536	Hoists, Cranes and Monorails																		S									
3537	Industrial Trucks and Tractors												P						S			PS						
3541	Machine Tools, Metal Cutting Types														PS							D						
3542	Machine Tools, Metal Forming Types														P													
3544	Special Dies, Tools, Jigs & Fixtures				S																							
3546	Power-Driven Handtools														P													
3547	Rolling Mill Machinery														P													
3549	Metalworking Machinery, NEC														D													
3555	Printing Trades Machinery												PD															
3556	Food Products Machinery																					P						
3559	Special Industry Machinery, NEC														S				S			P				S		
3561	Pumps and Pumping Equipment				D									S	P													
3563	Air and Gas Compressors				D											P												
3564	Blowers and Fans			D												D										S		
3566	Speed Changers, Drives, and Gears																									S		
3569	General Industrial Machinery, NEC												D		S													
3571	Electronic Computers					P			P				DS					P			S			P			P	S
3572	Computer Storage Devices																P	P							S			
3575	Computer Terminals																	P						P				
3577	Computer Peripheral Equipment, NEC		D				S			P			D				P	P			P			P				S
3578	Calculating and Accounting Equipment																	P						P				S
3579	Office Machines, NEC												D					P							S			
3585	Refrigeration and Heating Equipment											S				PS												
3599	Industrial Machinery, NEC								D						PS							P						
3612	Transformers, Except Electronic																											PS
3613	Switchgear and Switchboard Apparatus											S	DS								S							PS
3621	Motors and Generators			PD										S	PS	D										PS	P	P
3624	Carbon and Graphite Products												D															
3625	Relays and Industrial Controls				S				P				DS		P												PD	S
3629	Electrical Industrial Apparatus, NEC					P																						
3631	Household Cooking Equipment											PS																
3632	Household Refrigerators and Freezers											PS																
3633	Household Laundry Equipment											S														P		
3634	Electric Housewares and Fans											S														PS		
3639	Household Appliances, NEC											S																
3641	Electric Lamps																				P							P
3643	Current-Carrying Wiring Devices				D				S			S		S													PD	
3644	Noncurrent-Carrying Wiring Devices																			S								
3645	Residential Lighting Fixtures																				P					S		
3646	Commercial Lighting Fixtures																									S		
3651	Household Audio and Video Equipment																									P		
3661	Telephone and Telegraph Apparatus		P		S				PS			S	P	P			P				PS		PS		DS			
3663	Radio & TV Communications Equipment		P		PS	P			S	P			P	P	P						S		P		D			P
3669	Communications Equipment, NEC	P	PD		S				PS			P			S						S		P		P			
3671	Electron Tubes				S																							
3672	Printed Circuit Boards				D																							
3674	Semiconductors and Related Devices				S				S			P	PD		D								P	P	P		PD	
3676	Electronic Resistors												PS															
3677	Electronic Coils and Transformers														PS									P				
3678	Electronic Connectors				S									S														
3679	Electronic Components, NEC	P	D		DS	P	S		PS			S	PDS	PS	S			P			S		P	P	P	S		
3691	Storage Batteries				DS																							
3694	Engine Electrical Equipment				D											P							P					
3695	Magnetic and Optical Recording Media	P										P			P													
3699	Electrical Equipment & Supplies, NEC		D		S		S		S						S	P								P		S		D
3711	Motor Vehicles and Car Bodies			P	PD									D														
3714	Motor Vehicle Parts and Accessories				D								PD	PS	DS	P			DS							S		
3715	Truck Trailers												P															
3716	Motor Homes							P																				
3721	Aircraft	P					P			P	P	S	P		PDS	PD												

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3724	Aircraft Engines and Engine Parts				P										DS	PDS										S		
3728	Aircraft Parts and Equipment, NEC	P	D		D		P			P	P	PS	PD		PDS	PDS						P						
3731	Ship Building and Repairing			P															S									
3743	Railroad Equipment				PD								D													PS		
3761	Guided Missiles and Space Vehicles	P			S		P	PS	P	P			PD		D	D												
3764	Space Propulsion Units and Parts						P				P		PD			PD						P						DS
3769	Space Vehicle Equipment, NEC	P			PS		P	PS		P	P	S	PD		DS	D						P					PD	
3795	Tanks and Tank Components			P									P									P						
3799	Transportation Equipment, NEC														P							P						
3812	Search and Navigation Equipment		PD		PS	PD	PS		PS		P	PS	PD	D	PD	S								P			PD	DS
3822	Environmental Controls													D		P								P			PD	
3823	Process Control Instruments						S						P	DS	D												PD	
3824	Fluid Meters and Counting Devices								S					S	P													
3825	Instruments to Measure Electricity				S	P			S				D	D	PS												PD	
3826	Analytical Instruments				S										D													
3827	Optical Instruments and Lenses				S				S																			
3829	Measuring & Controlling Devices, NEC		D		S	P	S		S	P				D	S											S	PD	
3845	Electromedical Equipment																									S		
3851	Opthalmic Goods														P													
3861	Photographic Equipment and Supplies																								P			
3911	Jewelry, Precious Metal														P													
3949	Sporting and Athletic Goods, NEC								S						P													
3951	Pens and Mechanical Pencils														P													
3955	Carbon Paper and Inked Ribbons																P											
3993	Signs and Advertising Specialties														P													
3999	Manufacturing Industries, NEC								S																			
4011	Railroads, Line-Haul Operating																			S						S		
4013	Switching and Terminal Services																			S								S
4213	Trucking, Except Local																											
4412	Deep Sea Foreign Trans. of Freight			P																								
4492	Towing and Tugboat Service			P																								
4581	Airports, Flying Fields, & Services		P				S																					
4613	Refined Petroleum Pipelines																		S									
4741	Rental of Railroad Cars																									S		
4812	Radiotelephone Communications																				PS				D			
4813	Telephone Communications, Excl. Radio													P							PS							
4822	Telegraph & Other Communications													P														
4832	Radio Broadcasting Stations																									S		S
4833	Television Broadcasting Stations																									S		S
4899	Communication Services, NEC									P											PDS					S		S
4911	Electric Services																									S		
4922	Natural Gas Transmission																		S									
4941	Water Supply													S														
4952	Sewage Systems													S														
5013	Motor Vehicle Supplies and New Parts				D																							
5044	Office Equipment																								PS			
5063	Electrical Apparatus and Equipment																											S
5065	Electronic Parts and Equipment																				P							
5082	Construction and Mining Machinery																									S		
5083	Farm and Garden Machinery																									S		
5084	Industrial Machinery and Equipment															S				P								
5088	Transportation Equipment & Supplies											P				S						P				S		
5094	Jewelry & Precious Stones																											S
6141	Personal Credit Institutions				PS									S	P				S							S		
6153	Short-Term Business Credit													P	S		S		S									S
6159	Misc. Business Credit Institutions									P				PS	P						S					S		S
6162	Mortgage Bankers & Correspondents				P		S																					S
6282	Investment Advice																									S		
6311	Life Insurance				S									PS	PS											S		
6321	Accident and Health Insurance				S									PS	PS													
6331	Fire, Marine, and Casualty Insurance				S									PS												S		
6351	Surety Insurance													S												S		
6361	Title Insurance																									S		
6371	Pensions, Health and Welfare Funds														S													
6411	Insurance Agents, Brokers, & Service													S														
6519	Real Property Lessors, NEC																											
6719	Holding Companies, NEC													S	S				P		PS					S		
6794	Patent Owners and Lessors													S														
6799	Investors, NEC																		S									
7011	Hotels and Motels													PS														

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7359	Equipment Rental & Leasing, NEC																									S		
7372	Prepackaged Software				S		S			P							P	P			S							
7373	Computer Integrated Systems Design				S																							
7374	Data Processing and Preparation				S			PS		P								P			S							
7375	Information Retrieval Services																									S		
7376	Computer Facilities Management																											
7379	Computer Related Services, NEC				S					P								P			D					P		
7382	Security Systems Services		D																								P	
7389	Business Services, NEC				S			PS								P			S							S		
7513	Truck Rental and Leasing, No Drivers																									S		
7514	Passenger Car Rental																									S		
7515	Passenger Car Leasing																									S		
7519	Utility Trailer Rental																									S		
7538	General Automotive Repair Shops																									S		
7549	Automotive Services, NEC													P														
7629	Electrical Repair Shops, NEC																										PD	
7699	Repair Services, NEC																										PD	S
7812	Motion Picture & Video Production																									S		
8711	Engineering Services			P		P	P			P	P	S									D	S					P	S
8731	Commercial Physical Research								S				D			D											D	
8732	Commercial Nonphysical Research																				P							
8733	Non-Commercial Research Organizations								S																		D	
8741	Management Services											S									P							
8742	Management Consulting Services																				D							
8744	Facilities Support Services										P																	

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